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NAVAL PRIZE ESSAY.

THE CHANGES IN THE CONDITIONS OF NAVAL WARFARE, OWING TO THE INTRODUCTION OF THE RAM, THE TORPEDO, AND THE SUBMARINE MINE, HAVING REGARD CHIEFLY TO THE FOLLOWING POINTS IN OUR OWN AND FOREIGN NAVIES, VIZ.:—TRAINING OF PERSONNEL; CONSTRUCTION AND PROTECTION OF MATÉRIEL; AND ATTACK AND DEFENCE OF SHIPS AND HARBOURS.

By Lieutenant FREDERICK C. D. STURDEE, R.N.

"Tempora mutantur."

WE have divided the essay into four chapters, and will consider each subject separately, thus:—

Chapter I. Training of Personnel.
" II. Construction and Protection of Matériel.
" III. Attack and Defence of Ships.
" IV. " " Harbours.

We will first proceed to discuss the training of personnel, as it must always be the first thing to be considered, as ships without well-trained Officers and men to man them, would be useless.

CHAPTER I.—*Training of Personnel.*

This may be divided into two parts, (1) the training of the Officers; and (2) the training of the men; each part may be again divided into different parts, according to the different branches to which the Officers and men belong.

We will first consider the training of the executive Officers, and before stating any ideas that we may hold, will look about for some fair criticism on the education of naval Officers, of which no doubt there are many, but we will refer to one in particular, that is one by Professor Soley, who was ordered by the American Government to make a report on the different systems of European education, and he thus

sums up our system:—"Although it has made undoubted progress, it has been after all a long series of changes, experiments, renewed experiments, and expedients of all kinds, from which even now it cannot be said that a harmonious or satisfactory system has been evolved.

"In fact it is rather a combination of makeshifts, resulting from a series of tentative and spasmodic efforts in almost every form which naval education is capable of taking.

"The Naval Administration never seems to have looked at the subject as a whole, from the beginning in the entering examination of cadets to the final stage at the promotion of Sub-Lieutenants, and to have worked out a systematic plan which should have both cohesion and consistency."

He proceeds to criticize the different parts of the education, and his criticism is by no means favourable, as the above opinion shows.

There seems to be another awakening up to the fact that our education is not quite what the nineteenth century demands, as is shown by a committee being appointed to consider naval education, from which great results ought to be expected, but as we have not yet heard the result of their deliberations, we are at liberty to state whatever poor opinions we may hold on this important matter.

We will begin with a brief summary of the present system.

A cadet joins the Service between the ages of 12 and 13½—which many Officers consider much too young to begin the technical part of his education solely—but a compromise has been made, and he still is taught a certain number of school as well as technical subjects, but several important school subjects have to be dropped for want of time, such as Classics, English Grammar, and Literature. But now a little time has been devoted to these subjects, which is necessarily very limited on account of the many other subjects, and helps to make the course in the "Britannia" more of a cram, so much so, that it may safely be assumed that very few cadets get a good groundwork; the remainder having only a smattering of knowledge, as is shown by the comparatively few first class certificates obtained on leaving the "Britannia."

When the cadets go to sea, most of them are sent to ships with a Naval Instructor, who tries to impart more knowledge to them, but there are so many obstacles to be overcome, that very little is ever learnt by the majority of midshipmen at sea; besides a seagoing ship does not seem a suitable place to teach midshipmen subjects that could be learnt at school, thus wasting valuable time which should be given to strictly professional subjects.

The result is that when acting Sub-Lieutenants join Greenwich, they rarely know as much of the "Britannia" subjects as when they left that ship, while some may have been fortunate enough to have picked up a smattering of mechanics, and learnt a little more practical navigation.

The Greenwich course lasts for six months, when the subjects are again gone over, and all are a little more crammed for the final examination, a few hard-working and lucky Sub-Lieutenants obtaining first

class certificates; but as no encouragement is given to those that are not able to obtain firsts, a fairly large proportion only obtain thirds, and these must leave without having derived much benefit from the six months' instruction.

The torpedo course comes next, which is much too short, being only a month's course, so that there is very little time to obtain more than a general idea of torpedo work; this is particularly a course which everyone might and should do well in if they only work, but if they have been unfortunate at Greenwich it is not worth their while to work. This is the same with all the other courses, and might, we think, be obviated, if those who miss obtaining five first class certificates got some advantage, instead of, as at present, a Sub-Lieutenant with five thirds probably getting promoted as soon as one with three firsts and two seconds.

The gunnery course is a very good one, as it is quite long enough, and every Sub-Lieutenant who works, should go to sea with a good knowledge of gunnery. Pilotage comes next, which, we believe, has been recently altered, but still a great deal of time seems to be thrown away in learning tables by heart; and it might be made more practical.

The naval Officer's education is now complete, unless he wishes to take up a *spécialité*. If he studies for a Gunnery Lieutenant, which is the most advanced mathematical course, a great part of the time is taken up in re-learning elementary mathematics, and as the whole course is only nine months, not as much time as might be, is given up to higher mathematics. Our courses do not compare very favourably with foreign Officers' courses, as acting Sub-Lieutenants in Germany and *élèves* or naval cadets in France have the same standard to pass as our Gunnery Lieutenants, conclusively showing that our education is rather behindhand; this Professor Soley owned, although he said the courses in the "Excellent" and the "Vernon" left nothing more to be desired.

Having briefly examined our present system of education, we proceed to point out what seem to be some of the remedies.

The first fundamental change that is required is to increase the age of entry, so that a thorough groundwork of an education should be learnt at school, and the more advanced school subjects and technical education only learnt in the Service. The age of entry, we think, might advantageously be raised from between 12 and 13½ to between 14 and 15, as the old idea of cadets joining early was to accustom them while they are boys to the hardships of a nautical life, and also that it used to be considered that no one could become a thorough seaman unless the training was begun at a very early age; whereas now the hardships of a nautical life are very much minimized, and a naval Officer besides being a seaman should have a very good general education, besides a scientific education in order to take charge of the complicated ships of the present day.

It seems the most natural plan that the general education should be learnt first, and then the technical education, this plan being adopted in all other professions except the Navy.

The examination on entry should be fairly difficult, so as to get the best boys, the subjects for examination should be as near as possible those taught at the public schools, so as to prevent the system of cramming which is very prevalent now.

We have drawn up a list of subjects that the boys should have to take up, so as to give a rough idea of the examination they should be expected to pass.

The following is the list of subjects:—1. Arithmetic; 2. Algebra including Quadratic Equations and the different Progressions; 3. Euclid, 1st, 2nd, and 3rd Books; 4. Dictation; 5. English Grammar; 6. French; 7. Latin, I, II, and III Books of Cæsar, and 1st Book of Virgil; 8. Geography; 9. English History.

Optional Subjects:—At least three of these subjects might be compulsory:—Greek, German, Drawing, Physics, Trigonometry, Mechanics.

The candidates that pass would go to the "Britannia," but instead of being there only two years should be three years on board, then their age on passing out of the "Britannia" would be between 17 and 18. For the first year Latin and English Literature might be taught; but with the numerous subjects that should be learnt it is questionable whether there would be time for them, and all the time should be devoted to technical and professional subjects, or those subjects which are necessary to learn before being able to learn some of the technical subjects.

During the course the following subjects should be taught:—1. Algebra; 2. Euclid, as far as Book XII; 3. Trigonometry, Plane, Spherical, and Theoretical; 4. Practical and Theoretical Navigation; 5. French; 6. Kinetics and Kinematics; 7. Hydrostatics; 8. Physics; 9. Surveying; 10. Inorganic Chemistry should be taught during the 2nd and 3rd years; 11. Conic Sections should be taught during the 3rd year; 12. Shipbuilding and Naval Architecture should be taught during the 3rd year; 13. Steam should be taught during the 2nd and 3rd years; 14. Naval Tactics should be taught during the 3rd year; 15. Differential and Integral Calculus should be taught to a special few who are likely to understand it, and would be able to apply the knowledge, some encouragement should be given them to take it up, either by extra marks being given for it, or a prize for the one that passes the best examination in these subjects; 16. Two afternoons a week should be devoted to Seamanship; and cadets during their 2nd and 3rd years should go for a month's cruize during the summer in a training brig; this would be a relaxation from their indoor studies, and would be the best way of teaching them practical seamanship; they should work one of the masts, keep midshipmen of the watch, and do boat duty when in harbour, so as to teach them a little of their work as Officers. Then after coming back from their cruize, they could go on their summer's leave.

To carry out this proposed system properly, an increased number of instructors would be required, as now the proportion of two instructors to every term of from 40 to 50 cadets is hardly sufficient, as one instructor is hardly enough to teach from 20 to 25

cadets, but if there were three instructors to every term, the classes would be a very fair size, and there would be so much more instruction given; this would increase the number of instructors from 8 to 18, as there would be six terms on board, instead of four as at present, on account of the increased time in the "Britannia," but as we are recommending naval instructors being done away with at sea, it would be more economical than at present, where there are upwards of 35 instructors teaching midshipmen at sea; some of them are chaplains as well, so that these would still have an occupation in the Service. A few of these instructors should be particularly good men, so as to be able to lecture on mathematics, and particularly those that take the third year cadets.

Two natural science instructors would be required instead of one as at present. Great care should be taken to have good French masters, as the comparative ignorance of a great number of naval Officers in the French language must be due to the bad instruction they have received, and not sufficient importance being given to foreign languages.

An instructor would be required for steam, another for ship-building, another for chemistry, and one naval executive Officer to lecture on naval tactics. No instruction whatever is given at present in this important subject, naval Officers being expected to pick it up, which without some groundwork to commence with, it is very difficult to know where to begin. At present our ships are fitted with rams, and no one is taught how to use them, yet we are taught how to use guns and torpedoes.

The French fully recognize the advantage gained by having a large number of instructors, as they have 12 Professors, 8 Lieutenants, and a Chief Engineer, making 21 in all for an average number of 90 cadets only.

On passing out of the "Britannia" sea-time should be given in the same way as at present, so that cadets obtaining a year's sea-time will only have to serve two years more as midshipmen. During this time they would have to learn the practical part of their profession, viz., seamanship, steam, gunnery, and torpedo exercise; of course by this arrangement, two years instead of four years would only be served as midshipmen, but this is not so bad as it appears at first sight, as no time would be wasted at sea at school work, and the midshipmen would be always available for practical work; and if every midshipman is sent to a cruizer instead of an ironclad as at present, they would certainly get as much experience in two years as if they had been four years in an ironclad. A regular system might be devised to teach them their professional subjects. Every midshipman except the boat midshipman should keep watch, and at sea the senior midshipman of the watch should be allowed to work the ship under the Officer of the watch, the Officer of the watch in the day time being allowed to leave him in charge of the ship, the next senior midshipman of the watch doing duty as mate of the forecastle.

One day a week might be devoted to gunnery, one forenoon to torpedo work, one afternoon to steam, one forenoon to practical navigation, and two days to seamanship.

This would leave Thursday afternoon and the whole of Saturday spare, as at present.

Any instruction should be left off for a general evolution.

Midshipmen of boats not to be excused boat duty for instruction, so all midshipmen ought to take a turn as boat midshipmen. Midshipmen of the watch, if there is any particular work going on, not to be excused watch for instruction.

Midshipmen would be told off to tops and quarters as at present.

Out of the two days' seamanship, boat sailing, fleet tactics with steam and sailing boats, exercise aloft and splicing, &c., should be taught.

The afternoon devoted to steam should be employed with practical engineering, so as to enable every midshipman to know how to work an engine in case of an emergency, the theoretical part being taught in the "Britannia," and if possible when under steam one midshipman of the watch might be allowed to go down in the engine-room so as to learn further how to take charge of the engine-room and stoke-hold.

After being two years midshipmen, or between two and three years after leaving the "Britannia," according to the time obtained on leaving that ship, midshipmen would be eligible to pass the seamanship examination (they would be between 19 and 21 years of age).

This examination might be passed provisionally at sea, midshipmen should be able to work the ship (if they have been allowed to keep watch) and might be examined by doing it practically, besides the ordinary questions as at present.

If they pass, they should be sent home, and on arrival pass their seamanship examination finally before a specially appointed Board at Portsmouth; an arrangement like this would probably make more uniformity in the value of the different classes than is supposed to be the case at present by many Officers.

After passing in seamanship, they should not be sent to Greenwich, as the compulsory school subjects have been finished in the "Britannia," but instead, should go straight to the College at Portsmouth, where they would live as at present during the time they are going through the different courses.

1st. A month's course in steam; this would be a valuable addition to the present instruction, and the marks obtained in the examination at the end of the course might be added to one of the other subjects (in order to save an extra classification), say torpedo.

2nd. A three months', torpedo course, instead of a month, as at present, this would be a great gain to the Service, as it is always found on board the "Vernon" that Sub-Lieutenants pick up torpedo work quicker than any other class of Officers or men, and with the lengthened course a good knowledge of torpedo work would be obtained. A week at least of this time might be devoted to the management of the various kinds of torpedo-boats, so that in a few years we should have a large number of Officers that would know something about the management of these boats, instead of as at present when many Officers are appointed to torpedo-boats, they have

to pick up this knowledge after their appointments, as they may never have been away in one of these boats before.

3rd. A three months' gunnery course, the same as at present.

4th. A three months' pilotage course, which should be made as practical as possible, to enable any Sub-Lieutenant on leaving to have a good idea of how to navigate a ship from one port to another.

Captain Fitzgerald made a very valuable suggestion, that all Sub-Lieutenants should be taught the art of ramming in specially protected gunboats, so as to prevent them being seriously damaged if they are rammed; this instruction might be included in the pilotage course, a fortnight being devoted to it, as we think he recommended. The whole of this instruction with leave would only take one year, instead of eighteen months as at present.

Classes of certificates should be given for seamanship, torpedo exercise (including steam), gunnery, and pilotage, and a system of promotion devised according to the classes obtained; in fact as a rule all Sub-Lieutenants might be promoted on a certain fixed system according to how they pass, except a few special promotions for war service, gallantry, &c.

At present there is such an enormous difference between a Sub-Lieutenant that obtains five firsts, and another that obtains three firsts and two seconds, that many do not work as hard as they might. This we mentioned before.

No Sub-Lieutenant should be more than four years in that rank, except perhaps for some good reason.

The following is intended to give an idea of a scale of promotion according to the classes of certificates obtained.

Thus if a Sub-Lieutenant obtains—

1 1 1 1	he should only remain a Sub-Lieutenant for	6	months.
or 1 1 1 2	„	18	„
„ 1 1 2 2 or 1 1 1 3	„	2	years.
„ 1 2 2 2 „ 1 1 2 3	„	2½	„
„ 2 2 2 2 „ 1 2 2 3	„	3	„
„ 2 2 2 3	„	3½	„
„ or any lower classes	„	4	„

The classes in either subjects being considered all the same.

Sub-Lieutenants after being fully qualified, should be sent to any ships as at present, until promoted. When promoted it would be a great gain to the Service if half pay could be entirely abolished, except as a punishment or at an Officer's special request; this even if it could not be done in the senior ranks might be arranged for Lieutenants at a small extra cost to the country, but if the Officers that were not actually in seagoing ships were obliged to go through courses, the country would be amply repaid by having a better trained body of Officers; every one recognizes half pay to be one of the worst things for the Service.

Now would be the time when the good groundwork of an education learnt at school and in the "Britannia" would tell, as when Lieutenants went through a course at Greenwich very little time need be given to elementary mathematics, and then more advanced

mathematics could be learnt by those that wished to take them up. No one that has no taste for mathematics should be obliged to learn more than a certain amount, as it does them very little good; but those Lieutenants that do not wish to take up advanced mathematics might be allowed to choose what subjects they would like, professional subjects being compulsory, such as naval tactics and strategy, shipbuilding, steam, nautical surveying, international law, besides two or three non-professional subjects should be made compulsory which could be chosen out of a list of these subjects.

Besides the Greenwich course, every Officer should be obliged to go through a gunnery and torpedo course every three years, or whenever it is convenient.

Another course of practical engineering and shipbuilding might be given at Portsmouth. Opportunities should be given to Officers to go abroad and learn European languages, and to prevent them being put to any great expense, lodging allowance and travelling expenses might be refunded to them if they pass an examination in a certain time: this would make sure that they had not wasted their opportunities.

Lieutenants should be in every way encouraged to take up specialities, so that we should always have a certain number of Officers qualified for the different appointments that they may be expected to fill.

Thus certain Officers should be specially trained in gunnery, torpedo work, pilotage, steam, nautical surveying, naval construction, higher mathematics, and applied mathematics. Lieutenants should be expected to know as much as possible about foreign navies; and opportunities should be held out to them to find out more than at present.

We now come to consider the recruiting for the two specialities, gunnery and torpedo work.

The course should be kept the same length as at present, except for the Lieutenants who obtain first class certificates, who, after finishing their training and being fully qualified as either Gunnery or Torpedo Lieutenants, should go back to Greenwich for another nine months, so as to go through an extra course of higher mathematics and applied mathematics, particularly as relating to their particular work. By this means we should have a body of Officers able to superintend in the manufacture of guns, for which, if the Navy is ever to have charge of the construction of its own guns, we shall want some Officers more highly trained than at present. The torpedo Officers would be better able to teach more advanced electricity, &c., to the Officers' classes, besides being better able to superintend in the manufacture of Whitehead torpedoes, and probably more capable of bringing out improvements in torpedoes, &c.

On account of the higher standard reached in the "Britannia," the Greenwich course for the qualifying Lieutenants could be made more advanced than it is at present, and all the qualifying Lieutenants should take up higher mathematics, including differential and integral calculus, and an elementary knowledge of applied mathematics,

besides a more intimate knowledge of the subjects at present taken up.

Torpedo Lieutenants should have a more advanced course of electricity than at present. The course in the "Excellent" and "Vernon" might be kept the same as at present.

We next come to the training of the other branches of the Service.

The only other branch that the introduction of the ram and torpedo has in any way affected, as regards their training, is the engineer's branch. Their branch being comparatively a modern creation, has not all the old associations to shake off as the executive branch, and is educated according to the nineteenth century idea; this means that they have a good mathematical and scientific education, and we believe it leaves nothing much more to be wished for, as since the introduction of the Whitehead torpedo and the electric light, all Engineers and Chief Engineers are taught these subjects very thoroughly.

The Officers of the Royal Naval Reserve are our next consideration.

The only education we can be expected to give them is the practical instruction of how to use guns and torpedoes, and to be able to perform an executive Officer's duty on board a man-of-war. Seamanship has not to be taught them, as they are all seamen to begin with. We believe they have a very fair course of gunnery as regards the length of the course, but the guns they are taught to drill with are very often very obsolete.

At present they are not taught anything about the duties they would be expected to fulfil on board a man-of-war, although a few were attached to the Evolutionary Fleet; and it would be a great improvement if every year a certain number could be appointed to the Reserve Squadron during their summer cruize, where they could actually learn about a man-of-war; by this means on the declaration of war we should be able to fall back on a number of well-trained Reserve Officers to fill up some of the appointments in our large ships, which is very important, particularly when our number of Lieutenants on the Active List is so very limited.

We do not believe that they are taught anything about torpedo work; but it depends very much what they are intended to do, whether it is much good teaching them anything about torpedoes; as if they are only intended to officer armed cruizers, it probably would only be superfluous knowledge, unless there was spare time during their training.

Training of Seamen.

Before the introduction of steam, our blue-jackets were only expected to be thorough seamen, have a smattering about truck gun drill, and be able to use a cutlass; but at the present time our men, besides being seamen, must be gunners and torpedoists, and the difficulties of becoming a seaman have increased enormously on account of the introduction of steam, and the time spent in learning the other two subjects, besides the ships being longer in harbour.

The great question to be solved is, how first to make our men seamen, and then how best to train them in gunnery and torpedoes.

Boys on joining the Service go first to the stationary training ships, which we believe answer very well; but of course very little practical seamanship is actually learnt in them. The brigs are in commission all the summer months from the 1st April to the 1st November, so all boys that have served their time in the stationary ships are sent to the brigs during those months; but as no brig is cruizing for the other five months, a great number of boys never pass through the brigs at all, thus losing the most valuable part of their course. This might be remedied by increasing the number of brigs and arranging that all the boys that are likely to be drafted during these months should go to the brigs during the summer months.

Then it is important that more care should be taken where boys are sent after leaving the training ships, as now they are sent to harbour ships, ironclads, and cruizers indiscriminately.

The boys that are sent to harbour ships are only supposed to be six months on board of those ships, but they are very often nine months or a year instead. Imagine the small knowledge of seamanship they have when they go to sea, as the little they learnt when on board the harbour training ship is soon forgotten. We would propose, as a remedy, that there should be no boys' ratings in harbour ships, but ordinary or even A.B. seamen's ratings substituted instead; and that as many boys as possible be sent to seagoing cruizers, and as few as possible to ironclads, and none at all to mastless ironclads; neither should ordinary seamen be sent to harbour ships or mastless ironclads, unless they have served some time in a cruizer.

When there is a detached squadron—which for the good of the Service should always be kept in commission—boys and ordinary seamen should form a large part of the ship's company, having enough able seamen to get them into shape, and also in case of an emergency.

This is the principle which is adopted in the merchant service with the Officers, that every Officer is first taught to be a seaman, and then is eligible for a steam ship, and it is so far recognized that no large steam ship company take any Officers without they have served some time in a sailing ship; we believe this, that if it were more fully adopted into our Service for both Officers and men, great advantages would accrue from it.

We will now consider the training for the new rate of S.G.T.

The gunnery course lasts for four and a half months and the torpedo course for three months; at the end of each course there is an examination, and men get classes given them accordingly, so that they go to sea as S.G.T. first, second, or third class, or if they fail to pass, go back to the ordinary Service, without they bear a good character, and then they can become trained men.

By this means we get a large supply of men who are trained in the three branches, viz., seamanship, gunnery, and torpedo work; but it remains an open question whether we get such good men as if they

were only trained in one of these subjects besides seamanship, as to become a seaman gunner requires a different training to becoming a torpedo man, and it is generally found that men from the gunnery ships can learn by heart very well; but as a rule they cannot reason very much. Now torpedo work wants a good deal of intelligence, and parrot work is not much required. At all events we get a large number of the best men in the Service trained very fairly well in these subjects; but there seems to be an improvement which might be made to the present system—that is, that men who pass very well in either subject might be allowed to go through an extra course in that subject, for the reason stated above; many men pass much better in gunnery than in torpedo work and *vice versâ*, and at present we do not seem to take quite enough advantage of their extra qualifications. A certain limited number are recommended to qualify for gunnery or torpedo instructors and leading torpedo men; but in a ship, if we could get some more trustworthy men as gunners or torpedo men to hold some of the important positions, it would be a great thing. Now of course some of the S.G.T.'s are very well up, but with this system in a ship, we should have the instructors, &c., the S.G.T.'s who have been through an extra course (which should be marked on their certificates), and the ordinary S.G.T., so that we should have a large number of fairly trained men, the extra course men for captains of guns and torpedo carriages, &c., and the instructors, which would be a very good complement of trained men. All men passing for trained men at sea should be obliged to go through a short torpedo course; this would be a great help to them when they came home and wanted to qualify for S.G.T.

Now that torpedo-boats are becoming more numerous, a certain number of good petty officers who are S.G.T.'s, should be trained to steer and manage these boats, and if they prove themselves proficient should receive extra pay, and be given a special rating as coxswain of a torpedo-boat. This has been several times recommended, and is nearly a necessity, as the steering of a torpedo-boat is by no means such an easy thing as it appears at first sight, and men want practice in them before they can steer them at all well.

The next branch of the Service we have to consider is the engineering branch, the men of which branch are very fairly trained, as far as the engines of our large ships, &c., are concerned, but are not well enough trained in the working of torpedo-boats; at the commencement of a war this would prove a great difficulty. At present they rather avoid the boats, as the work is not so very pleasant; but if an inducement in the way of pay were given, we should get many of the best artificers and stokers to volunteer for the work, and these boats certainly require the best men to get the speed they should realize out of them.

There is another point: stokers should be trained to use a rifle, as since the introduction of steam, the gradual increase in the number of stokers and artificers in our ships, and in consequence of the masts being abolished, the decrease in the number of seamen in our ships, it becomes a matter for serious consideration, whether for the defence

of our ships against torpedo-boat attacks, stokers should not be taught how to handle, load, and fire a rifle, as now only forty to fifty per cent. of a ship's company can use the rifle, whereas in the French Navy only five per cent. *cannot* use a rifle. Why should not we copy their good example?

We do not mind so much about stokers knowing how to drill with the rifle, as that is superfluous; but all we want of him to know is to aim and be able to hit a boat, say at 800 yards or less. Now as a rule when a ship would be attacked by torpedo-boats, she would be at anchor, when all the stokers would be more or less available, and if it happened at sea, the greater part would be also available.

The training required would be comparatively little, viz., a ten days' course in the gunnery ship, the annual firing when abroad, and whenever the men are exercised at manning ship.

Special inducements might be given to men to shoot well, such as a penny or twopence a day extra. The idlers would do for ammunition men; therefore it would be hardly worth teaching any of them the use of a rifle.

The remarks we made with regard to the Officers of the Royal Naval Reserve will apply to the men, except that it is not so necessary that they should serve on board of a man-of-war even in peace-time.

Chapter II.—*Construction and Protection of Matériel.*

This is a subject which seems at present to be left rather too much to the Constructor's Department, and instead of naval Officers being first asked what kind of ships they require, the constructors seem to be left to build the ships, while we have to fight and make the best of them. We would humbly suggest that there should be a Board of naval Officers appointed to arrange what are the best types of ships that should be built, and to examine the drawings, &c., to see if they meet their views, and make whatever alterations they may deem desirable, in consultation with the constructors, subject of course to the approval of the Controller of the Navy and the Lords of the Admiralty (the former might be the President of the Board).

In a Navy like ours which has such various duties to perform, it seems important that we should have ships built for certain duties, and if possible at the same time able to perform other duties, and we would recommend that ironclads should be divided into three classes, each class intended to do some particular kind of work.

The classes might be—

1st. Line-of-battle or fleet ships.

2nd. Ironclads of lighter draught and not so powerful (specially intended for going through the Suez Canal or for bombarding forts).

3rd. Coast defence ironclads.

The 2nd class of ironclads seems to have been rather forgotten lately, which is perhaps a mistake, as at any time it may be very important to concentrate a powerful fleet in the East, particularly owing to the increasing fleets of both Russia and France in the China Seas;

and now that Germany is also beginning to have interests in Eastern waters, she will no doubt always keep a fleet in those waters. This was also shown at Alexandria, where out of the whole Mediterranean Fleet we could only bring two ships into the inner harbour (viz., the "Invincible" and "Monarch") to bombard the forts, and an obsolete ironclad like the "Penelope," which was supposed to be guarding our own coast, had to be sent out to augment the fleet.

Now of late years, since the "Iron Duke" and the "Audacious" were built, the "Shannon," "Nelson," "Northampton," "Ajax," and "Agamemnon" are the only ironclads that have been built to augment this class—the two last of these ships, however, are notably bad ships for steering—these are about the only new ships that are able to go through the Canal.

First. Ironclads for the line of battle.—The "Admiral" class are the ships at present being built to augment this class, they answer the requirements fairly well, only there are a great many things about their construction, as well as about the construction of the "Inflexible," "Colossus," "Ajax," and "Agamemnon," which have never been practically tried, and which many naval Officers who are well capable of expressing an opinion do not believe in, and therefore it seems advisable that they should be tried before any more ships are built like them. It is the much-discussed question of the unarmoured ends, which as Captain Fitzgerald and Sir Edward Reed point out very clearly has been very much modified by the introduction of machine-gun fire, and if, as they point out, the water-line is riddled and the ships are not safe under those conditions, it would certainly seem advisable to modify this to some extent, as what is the use of having an impenetrable citadel, if its floating power is removed from it?

Therefore we should recommend that this should be fully tried, and in the meantime either no new ships should be laid down at all, or the ships that are laid down be designed with a complete water-line belt, which we would very much prefer, like the "Amiral Duperré's;" if the belt be made sufficiently thick, weight might be taken off by only having an armoured deck over the vitals of a ship, except in ships intended for bombarding, which ships should have a specially thick armoured deck to protect them against plunging fire.

The belt ought at all events to be thick enough to protect the water-line against quick-firing guns, say 4 inches of armouring, then a complete armoured deck would still be required; the extra weight might be taken off the armouring of the vital parts, or better still, the tonnage of ships, if absolutely necessary, might be increased to allow for the extra armouring.

The barbette principle for firing large guns we believe is the best one, only the barbettes in the "Admiral" class of ships are not sufficiently protected from the plunging fire from the enemy's tops, and if the hurricane deck were extended and protected with 2-inch armour immediately over the barbette, it would prove a great protection to the men in the barbette. The French recognize this, and the barbettes of the "Amiral Duperré" are protected by an armoured hurricane-deck.

The barbettes should be armoured with thick armour all round, and the tubes leading to them also, so as to prevent them being easily disabled.

The main deck battery of 6-inch guns is a great improvement over the original armament of the "Inflexible," with her four huge guns which took a long time to load, and the defects of which were fully shown at Alexandria.

The conning towers should be well protected as they are at present, and the different firing keys and fittings in them should be made as simple and easy to distinguish as possible. Now many of our conning towers would be a perfect puzzle in a general engagement; simplicity should be more considered in fitting them up.

These ships have a good many machine-guns, but so many different types are being introduced into the Service, that the supply of ammunition for them all will prove a considerable difficulty.

Each of these ships should have at least six Whitehead discharges. One forward in line with the stem, but clear of the ram, one aft over the stern, so as to shoot a torpedo between the wakes of the two screws, and two on each broadside, with the new Mark V carriages fitted to train from 75° before or abaft the beam to 10° abaft or before the beam. We are very much surprised that one of our most modern ships, viz., the "Colossus," has only two Whitehead discharges, this in the present day seems an important defect, and all ironclads should have at least four Whitehead discharges. A great step in the right direction has been made in doing away with masts and yards in these ships, and substituting in their place military masts; it seems questionable whether another top to each mast would not be an improvement, on account of the increasing importance of machine-gun fire from ships' tops; for the same reason it is a matter for consideration whether a small armoured tower should not be built for signalmen to be able to work in during an engagement between fleets, as now it would be impossible for them to remain on deck, when within short range of the enemy; the signal halyards could easily be worked through slits in the top of the tower, and the flags could be stowed in lockers placed round the inside of the tower. These ships should also be fitted with a complete and very efficient net defence.

If turret-ships are again built, the "Dreadnought" class should be copied in preference to the "Inflexible" class, particularly with regard to the positions of the turrets and the armoured belt, the "Dreadnought" being generally considered one of our most successful modern ships.

We now come to consider what duties the 1st class ironclads are expected to fulfil. Their principal duty is to form part of the different fleets we may require, which are at present the Mediterranean, Channel, and the Reserve Fleets (the Reserve Fleet, if our coast were properly defended by coast defence vessels, would be able to form a Channel Fleet, leaving the Channel Fleet free to go anywhere it was required), and perhaps one of the 1st class ironclads might be wanted to go out on some station where any foreign nation had a more powerful ironclad than any of our 2nd class ironclads.

The ironclads would therefore require a high speed, in order to cope with any foreign fleets with high speed they might have to encounter; their speed should not be less than 15½ to 16 knots, they will not want an abnormally large coal capacity, as they would not be expected to go very far from where we have coaling stations, but it always must be remembered that they trust to steam alone; their coal capacity, therefore, should be very considerable, say at least six days at full speed.

They should always be fitted with twin screws, steam steering gear, electric search lights, and lighted internally by electricity.

At present not enough care is taken to ventilate certain parts of the ship, the dynamo room is nearly always badly ventilated, which is most injurious to the machines, as it tends to melt the insulation of the wires; there should be very little excuse for this, as a fan could be put on the same shaft as the armature of the machine, which would at all events circulate the air well. In the "Colossus" the hydraulic room and the dynamo room are intensely hot. The electric search lights in all ships should be placed very low, instead of very high as at present, and an arrangement has been recommended to work it out of a main-deck port, which should be tried and fitted.

The 2nd class of ironclads should take the place of what are usually called 2nd class ironclads, these merely being built either as small ironclads, or have become obsolete, originally being 1st class, without reference to their draught of water. The 2nd class ironclads we hold should be built either for foreign stations, or for bombarding forts which are surrounded with shallow water, but for whichever purpose they should draw little water.

In size they should be smaller than the line-of-battle ironclads, but might be built according to the same idea, that is to carry, say, two heavy guns in armoured barbette towers, and several smaller guns in an unarmoured battery, have an armoured belted water-line, very large coal capacity, rigged so that in case of coal running short to be able to cruize about fairly well under sail, should be fitted with a complete net defence; electric search light (placed low as before); internal lighting would be a great advantage when under steam, but it is questionable whether it would not be considered too expensive, as it could not always be used. These ships should have room to carry a larger number of mines than at present, as they may at any time get disabled, and have to take refuge in a harbour, so that we would propose that twenty-four instead of six should be carried, besides the countermines. The ones intended specially for bombarding forts should have a complete armoured deck, and thicker than usual, some of the armour being taken off the sides if necessary.

The coast defence ironclads of late years seem to have been rather neglected, none having been built since 1872, and then only six; it therefore seems time that some more were built; besides these we have about thirty gunboats of the "Bloodhound" class and a dozen of the "Medina" class, but several of these are abroad defending a few of our coaling stations, but from their usual be-

haviour in a seaway we can hardly look on them as very satisfactory to defend the coast, although they may be very good for defending certain harbours, where they would be in more or less smooth water. In going round to join the Evolutionary Squadron, the fleet were delayed about ten days waiting for the gunboats, they being weather-bound; this points to the fact they are too small for coast defence, and we would recommend for the defence of the coast a mean between the coast defence ironclad and these small gunboats.

A coast defence vessel should possess the following qualifications:— 1. Light draught; 2. Handy; 3. Able to steam from port to port with safety in bad weather; 4. Good guns; 5. A fair speed and ordinary coal capacity; the speed and coal capacity being secondary considerations.

We would recommend gun-vessels of the "Wespe" type, which is a type of gun-vessel built by the Germans for the defence of their coast. They are 142 feet long and have 35 feet beam, and in Germany are armed with a 12-inch 36-ton gun, for which we would substitute a 43-ton gun, mounted in an open circular breastwork, and protected with 8-inch plating; besides the large gun they should have one or two 5-inch B.L. guns aft, and several machine-guns; they have twin screws and steam steering gear.

These gun-vessels would be more what we require than anything we have at present, and are necessary for the defence of our military ports, coaling stations, and the principal commercial ports. They should be stationed at their ports during peace-time, so as always to be ready for any emergency.

Besides these three different kinds of ironclads, owing to the introduction of the Whitehead torpedo, another type is now required, called a torpedo ram. These craft should be very fast, should possess quick turning power, numerous Whitehead discharges, be unsinkable, and almost entirely submerged.

The "Polyphemus" answers these conditions very well, and has proved herself a great success, therefore it seems very important that more ships of her type should be built, so that one or perhaps two "Polyphemus's" might be attached to each fleet.

The "Scout" class answer these conditions to a certain extent, but they do not seem to be unsinkable, and are very much exposed to hostile fire, besides not being able to steam quite fast enough, but would no doubt be an acquisition to any fleet.

We next come to the unarmoured ships, which might be divided into the following different classes:—

1. Swift cruizers and despatch vessels; 2. Corvettes; 3. Sloops; 4. Gun-vessels; 5. Torpedo depôt ships; 6. Armed merchant ships.

1. *Swift Cruizers and Despatch Vessels.*

The following seem to be the principal qualities that a swift cruizer should possess:—

1st. Great speed; 2nd. Large coal capacity; 3rd. Long-range guns; 4th. Several Whitehead discharges and ability to carry two torpedo-

boats, and hoist them out at sea; 5th. Handiness; 6th. Manœuvring power under sail.

We have put handiness very low down in the list of requirements, as they will never form part of the line of battle, therefore it is not so much required, and too much seems to have been sacrificed for it in many of our cruizers, such as the "Iris," "Mercury," "Leander," &c., and if we consider what duties they are expected to perform, viz., 1st. Protect our trade; 2nd. To attack and destroy the enemy's cruizers and armed merchantmen; 3rd. To act as the eyes of a fleet, and convoy some of the torpedo-boats during an action; it does not appear that we want a particularly handy ship, but we do want a very fast ship, at the same time being an economical steamer, possessing a large coal capacity and very good offensive powers.

Now it is generally found that one of the best ways to get great speed, and at the same time economy, is to make ships very long, with of course good lines, which at the same time allows a larger space for coal.

Therefore we would recommend that instead of limiting the length of these ships to 300 feet between the perpendiculars, it might be advantageously increased to 350 feet.

This would no doubt enable them to steam at least an ocean full-speed of 18 knots, and this without any fear of a breakdown, or wanting a great number of extra men as coal trimmers, as is we believe the case in the "Iris" when going full speed.

Their coal capacity, instead of being 750 tons, which is all the "Iris" carries, should be much larger.

These cruizers should be fitted with twin screws, their engines and vital parts should be protected with a 2-inch armoured deck, should carry a large number of 6-inch guns and machine-guns, should have four Whitehead discharges on the beam, and if possible one over the stern, carry two torpedo-boats, their rig should be light sufficient to be able to cruize about under sail, and with fires banked if required. Besides these larger despatch vessels, of which we ought to possess several, we come to the despatch vessels, which should possess an ocean speed of at least $16\frac{1}{2}$ knots, of the "Leander" type; the "Surprise" and the "Alacrity" are going to be armed, and will make very formidable despatch vessels, but we should think they have hardly enough room and beam to carry a large armament, but they are a decided advance on the few unarmed despatch vessels we possess at present.

2. *Corvettes.*

We want a large number of this class of vessel for our foreign stations, but at present most of them are not fast enough to be of much use to protect our merchantmen.

They seem to labour under the same disadvantage as our swift cruizers, that is, that they are not long enough to develop a large and economical speed, and in this respect it is considered by many Officers that our smaller vessels particularly are not as good sea boats

or do not steam nearly as well as those of some of the other European nations.

Thus the C class, the latest type of corvette being built, are only 225 feet long, and have a speed of only 13 knots, which is less than the speed of many ironclads, and thus they would fall an easy prey if they met an ironclad. We think these ships should have at least a speed of 15 knots and ought to be better sea boats, therefore they might be made a little longer, as now they are extremely short. The ones that are armed with B.L. guns are very formidable opponents, besides having two Whitehead discharges, which all corvettes should have now. They also are very well divided into numerous water-tight compartments.

3. *Sloops and Gun-vessels.*

The great complaint against some of these vessels is their small speed and their being bad sea boats; but some of the newer sloops are better in these respects, and the gun-vessels and gunboats are being better constructed, as it seems worse than useless to own gunboats which can hardly steam 4 knots, which is about the speed of some few of our older gunboats, partly no doubt being due to the bad state of the boilers.

4. *Torpedo Depôt Ships.*

The torpedo depôt ship is quite a new requirement, and every year is becoming a more necessary addition to a fleet.

We only possess one of these vessels at present, viz., the "Hecla," but we believe the drawings are made out for another.

A torpedo depôt ship should possess the following qualifications:—

1st. Speed of at least 16 knots.

2nd. Large stowage capacity for coal, mines, cables, &c.

3rd. Ability to carry 1st as well as 2nd class torpedo-boats, with very good appliances for hoisting them out at sea.

4th. Good workshops sufficient to keep the torpedo-boats of a fleet in good order.

5th. A few 5-inch B.L. guns and a large number of quick-firing guns.

6th. Several Whitehead discharges, particularly one right astern.

One of these ships should be attached to every fleet, and where the fleet consists of over nine ships, there should be two of them.

This was shown at Bantry Bay, where the "Hecla" had to supply gear for all the ships, besides having to coal, water, and generally look after the torpedo-boats: this was too much for one ship to do.

We have placed speed first in the list of qualifications, as with six or eight torpedo-boats, and a large amount of mining stores, they would be a valuable prize for an enemy's cruizer to take; besides speed is very necessary for them, in order that they could be used to carry torpedo-boats for a torpedo-boat attack, if it were required to make an attack on some distant port, as being fast, they could come off a port after dark, hoist out all their torpedo-boats, send them in, with orders for the boats to meet the ship at a certain rendezvous after the attack

has been made, then hoist them in again, and having good speed need not much fear being captured.

The "Constantine" in the Russo-Turkish War performed this duty very well, and without a ship of that type the various attacks on the Turkish ships in different ports could not have been so easily carried out. Although now the new boats that are being built are 125 feet long and are supposed to be able to keep the sea; besides being too large to hoist in; but for a long cruize it would be advisable they should be convoyed, in case of any of them breaking down, these would be very suitable ships to perform this duty.

5. *Armed Merchant Steamers.*

With a large mercantle marine like that we possess, we ought to be able to find a fair proportion of fast steamers possessing the necessary requirements to enable them to be armed and used to protect the commerce, and in fact at present we have at least 400 on the Admiralty List which are fit to be armed and used as armed cruizers; 100 of them being able to steam more than 13 knots. Since the idea was first started, we believe the large shipowners have been only too ready to build their new ships according to the Admiralty requirements.

Now in time of war our commerce is the great national weakness, and it is one of the great questions how we should efficiently defend it, and the first thing we have to consider is what ships we should use to defend it with.

Of course there can be no question that to have a large number of fast cruizers belonging to the Service would be the best way, if they were kept up to the latest requirements, but there are various things to be considered, which modify this view.

The first, which unfortunately has always to be considered, is the great expense to build a sufficiently large number of fast cruizers, and secondly, again the expense of keeping them up to date, and the different improvements this would entail.

Therefore for these reasons we must trust to arming the best of our merchant steamers, which method possesses the following advantages:—

1st. They do not cost anything in time of peace.

2nd. Amongst the large steam ship companies there is a great deal of competition, therefore the new steamers that are built are always of the best kind, and every improvement is introduced to give them good speed and at the same time to make them more economical steamers.

3rd. As there are fittings and guns sent out to certain depôts abroad, these steamers can be hired abroad, and sent to these depôts to arm when required; whereas if we trusted to our own cruizers they would most probably be at home and paid off, thus valuable time would be lost in fitting them out and sending them abroad.

4th. Being generally larger and possessing large hold space, they are able to carry a large quantity of coal, thus being able to keep the sea

for a long time. There are, however, several disadvantages in hiring merchant steamers, instead of possessing a sufficient number of our own cruizers, viz.:—

1st. As the Admiralty List includes most of the finest steamers, it takes away a certain number of steamers that are better able to defend themselves than the slower steamers, besides crippling to a certain extent the mail service, which becomes very important during war time.

2nd. That the steamers are not ready like men-of-war should be, and from want of practice, the process of arming them takes a considerable time.

3rd. That many of their decks and even those on the Admiralty List are hardly strong enough to bear heavy guns.

Considering the above advantages and disadvantages, it is evident that the best thing is to trust to arming merchant steamers.

During the late preparations for war, sixteen steamers were hired for six months certain, varying from 17*s.* 6*d.* to 1*l.* 10*s.* per ton a month, including the crew being paid, or if the Government paid the crew, from 12*s.* 6*d.* to 1*l.* per ton. Most of these steamers were taken in hand and prepared for arming, but war not being declared, only one steamer, the "Oregon," was actually hired, and we believe answered very well.

Her armament was four 5-inch B.L. guns, and six 64-pr. muzzle-loading guns, which was the same as was intended for several of the others, and is a fairly good armament, particularly if the 64-pr. guns were fitted with a slide; truck guns are not suitable for merchant vessels, as they jump too much for the weak decks of merchantmen.

If better guns can be procured, 64-pr. guns ought not to be used at all, as they are very inefficient as compared with the modern guns, and unfortunately all the guns and fittings abroad are for 64-prs. This seems rather unfortunate, as an armed merchant steamer capable of steaming between 16 and 18 knots for a long time, and with a large capacity for coal, rivals most of our own cruizers, as they can only steam fast for a comparatively short time, on account of their limited bunkers; therefore it would seem advisable to give them a very good armament of the most modern guns, and a good many machine-guns instead of a net defence, which would hardly be required.

It is also most important that they should be armed very quickly, as on the first outbreak of war if we have not many cruizers to protect our merchantmen, we should be certain to lose a great number of ships if at war with a naval Power.

Now in England there ought to be no excuse about the ships not being armed quickly, because fittings should always be ready, and a plan for arming each ship should be made out during peace-time, then the only thing that would be required would be to fit the different things in place, and where the decks require to be strengthened that might be done, or arranged for while the ships are being built.

Abroad the case is different, as although the fittings are at the different depôts, in some places we believe there are not enough men

to fix them in place, and men have to be lent from the ships on the station.

This might be arranged otherwise, so that wherever there are fittings there should be sufficient men to put them in place, and to do it quickly.

Merchant steamers, besides having to be armed, would be required for several other duties, viz., as transports, colliers, store ships, extra torpedo depôt ships, telegraph ships for laying and repairing telegraph cables.

A great number of steamers would be required as colliers, and it is important that they should be fairly fast, as a means of protection, and besides should be fitted with some arrangement for coaling ships at sea; this would be one of the most important duties for a collier to be able to do, as we imagine every fleet will have some colliers attached to it, according to the particular kind of work it is doing, and particularly if it is blockading an enemy's coast, as it would be almost impossible to be always sending ships away to the nearest port for coal.

Several different proposals have been made by Officers, and it seems very important that one of these plans should be tried, as the expense would be very trifling. What is required is speed in coaling, and the ability to coal a ship while she is under weigh, as in a large fleet the delay would be very considerable if it had to stop for each ship to coal.

A certain number of telegraph steamers will be required in wartime, in order to repair telegraph lines and lay down fresh ones, and it becomes a matter worthy of consideration how we are to defend them, as if an enemy's cruizer caught them unarmed while laying a cable, they would stand a small chance without they cut the cable and ran. It would, perhaps, be a mistake to arm them, but when they are likely to meet an enemy's cruizer they would either have to be convoyed or armed. We are inclined to think convoying in these special cases would be best.

We have now to consider more particularly the external defence necessitated by the introduction of the torpedo and submarine mine.

First, all ships down to the smallest gunboat should be fitted with a complete and efficient net defence.

This is the best and probably the only efficient way of satisfactorily defending a ship against Whitehead torpedoes.

Now a good net defence should possess the following qualifications:—

1. It should be rigged altogether from inboard, without using any boats.

2. Should be rigged and unrigged very quickly.

3. The topping lifts and guys should be clear of the fire of the guns.

4. The ship should be able to steam at least 5 knots with the nets out, and be able to keep the nets out in moderately rough weather.

Several different plans of net defence have been tried in different

ships, but the defence of the "Dreadnought" seems at present to be the best, and all turret ships are being fitted on this plan.

The fourth qualification is at present a difficult one, as when a ship is under weigh, the bow and stern defences are very difficult to keep in place, the bow defence tending to sag in towards the ship, and the stern defence gets washed to the surface; but now that ships are defended completely this ought to be overcome better.

Second, machine-guns, which we have mentioned before, should be fitted to all ships, their number and positions varying according to the size of the ship.

It is hardly necessary to point out the advantages of machine-gun fire in the day time for repelling a torpedo-boat attack; but at night it is questionable whether they are of very much use; this question will no doubt be fully tried in the "Polyphemus."

Third, the electric search light.

All large ships should be fitted with a dynamo that will burn at least two search lights at once, and the projectors should be placed in the main deck ports, and the lamp should be automatic, the projector manipulated from a distance, as if this could be devised it would be an improvement on the present arrangement, as now the operator manipulates the lamp and projector close to it, where he cannot see anything, and has to be directed by some one at a distance; very often he moves the projector too far, and thus misses the boat.

Corvettes and all smaller ships should be fitted with a dynamo, to burn one light at a time, and either one or two projectors, according to the size of the ship, which should be placed as low as possible, and clear of all obstructions.

Several different methods have been proposed to be adopted in the construction of our ships, to prevent the bottom being penetrated by torpedoes. Of course the protection we adopt in the construction of our ships is watertight compartments, by subdividing a ship into as many compartments as possible, and so reducing the chances of destruction to a minimum; but during the last two or three years the charges used in the Whitehead torpedoes have increased from 30 lbs. to 65 lbs., and in the 19-feet torpedo to 94 lbs.; it becomes therefore a matter for consideration whether some other means besides watertight compartments should not be adopted to prevent ships being destroyed by torpedoes.

Sir Edward Reed recommends that ships should have an armoured inner skin to prevent the explosion of a torpedo penetrating both bottoms. This seems worthy of trial, and experiments might be carried out to prove if it is an improvement on the present arrangement; a small ship might be fitted, like the "Oberon" was, except that it should have an armoured inner skin, and if it proved satisfactory a larger ship might be tried. Of course the great objection to this system is the extra weight, which would have to be taken off the armour above water, but it would be by no means thrown away.

There is another proposal to cover a ship's outer bottom with india-rubber or canvas, which answers very fairly well when tried with boats; but the great objection to it is the chance of it deteriorating, and it would increase the skin resistance of a ship.

Chapter III.—*Attack and Defence of Ships.*

It is generally advisable when trying to master a subject, first of all to see what we can pick up from the experience gained by our forefathers, but unfortunately in this subject, under the altered conditions of naval warfare since the introduction of steam and torpedoes, we have very little of this experience to refer to, as fortunately for ourselves we have not been engaged in any naval war since our ships have been propelled by steam as in the Crimean War, our ships hardly ever met a Russian ship at sea, two of our smaller ships, however, felt what a submarine mine was like, luckily the charge was only 20 lbs. of powder, or otherwise they would have been totally destroyed.

It is not generally known that torpedoes were used against our ships as long ago as the War of Independence with America, and also in the last war with that country in 1812, but with no serious results, except a prize schooner was destroyed by a torpedo which had missed the ship, which one of the men got hold of and was examining when it exploded and destroyed the schooner, also one of our ships got her forechains blown away, and had a boat destroyed by another torpedo.

Fulton also tried to use them against our ships during the last war we had with France, but with no success.

These few attempts in no way influenced our tactics, except to make our Officers look out for these new hidden dangers, so that in our own history we have nothing to learn about the attack and defence of ships since the introduction of steam and torpedoes. When we look abroad, there have only been three naval actions between fleets during this period, the best known of these being the Battle of Lissa between the Austrians and the Italians. The lessons we may learn from this action are as follows :—

1st. Single column line ahead in open order (particularly when the ships are not in station) is a bad formation to receive an attack from another fleet.

2nd. That ramming is by no means so easy as it is very often supposed to be, as if the enemy is on the alert it can be very often avoided by the helm, even at the last. Thus the "Ferdinand Max" made two attempts to ram two different ships; both were avoided by the use of the helm, but the third attempt, against the "Re d'Italia," was successful; she rammed her under the counter and sank her, but it should always be remembered that the "Re d'Italia" was at the time surrounded by three other Austrian ships, which must have prevented her from manœuvring to prevent being rammed.

3rd. To ram a ship, the rammer must have good speed and good steering gear, which was practically shown by the two ineffectual attempts of the Italian ship "Affondatore" to ram two of the Austrian ships.

4th. Ships that intend to ram, or are liable to be rammed, should have no projections from the ship's side, as was shown by the "Re di Portugalo's" attempt to ram the "Kaiser Max," which the latter

avoided by turning towards the former ship and going full speed, in consequence of which the ships rubbed sides, and brought down the "Kaiser's" foremast.

This is a matter which we ought to think about, as many of our ships have projecting sponsons, to enable guns to be fired either ahead or astern, and all ships will be armed with very long breech-loading guns, which will not be able to run in far enough to prevent the muzzle projecting beyond the ship's side; consider what would be the effect of two ships rubbing sides with all the guns of one of them being run out. We think that there could hardly be a doubt but that they would be all dismounted. Thus what would otherwise have been a harmless rub has dismounted one broadside of guns. Are the sponsons made strong enough to be able to stand two ships rubbing sides? If they are, and they project a little more than the muzzles of the guns when they are run out, we have solved the difficulty.

The next naval action between two fleets was the Battle of Heligoland, between the Austrian and the Danish fleets, but it was undecisive, one wooden ship only being set on fire.

The third was between two gunboat flotillas, on the Mississippi; the Confederates came off worst; several were rammed and sunk on each side.

Also in an engagement between a ram and several wooden ships, two sailing frigates and a gunboat were sunk by Confederate rams, and several ships were disabled by shots through their boilers; there were also two or three ineffectual attempts to ram.

In the war between Chili and Peru, the "Huascar" made two attempts to ram the "Esmeralda," the "Esmeralda's" engines being disabled at the time; the cause of these failures was that the "Huascar's" engines were stopped too soon; the third attempt was, however, successful, and the "Esmeralda" was sunk. In the same action the "Independencia" made three attempts to ram the "Covadonga;" the fourth time, instead of ramming her, she ran on shore.

In the action between the "Huascar" and the "Cochrane" and "Blanco," the "Cochrane" made three attempts to ram the "Huascar." The "Huascar" at the time was very much disabled. The "Huascar" also made an attempt to ram the "Blanco," which the latter avoided by using her helm.

These are the results of the only engagements in which ramming has been used.

Torpedoes or torpedo-boats were not used in any of these actions, we have, therefore, no former experience to gather anything from relative to the use of torpedoes in actions between ships.

We have not mentioned anything about the damage the guns did in the different actions, as the art of gunnery, though it has improved enormously, has been nearly counterbalanced by the vast improvements made in the construction of ships.

Machine-guns were not used in any of these actions, except in the latter between the Chilians and the Peruvians, when the machine-guns in the tops of the "Cochrane" successfully cleared the

"Huascar's" upper deck; this points to the fact of some protection being given to signalmen, as we mentioned in the last chapter.

Before considering what tactics to adopt, it is advisable, first, to decide which of the three weapons (viz., the gun, ram, or torpedo) is most effective, so that the tactics may be arranged in order to bring the best weapon into play to the greatest advantage.

Of course if the ship or fleet were badly armed with this particular weapon, the best would have to be made of the other two weapons, and tactics should be adopted so as to bring the best weapon of the two into play to the greatest advantage.

Most writers on naval tactics seem to place the ram as the first weapon of attack, and all tactics are made out with a view of ramming the enemy as soon as possible, and, if successful, bringing the action to a successful close. They recognize the gun as a very useful and powerful weapon; but the effect of a single shot, or even a broadside, is not nearly as effective as one ship merely drifting across another's bow, as was shown when the "Northumberland" parted her cable off Madeira, and drifted across the bows of the "Hercules," and far less so when a ship with a good speed rams another ship; for these reasons the ram has been placed before the gun.

But writers have hardly noticed the latest weapon which has been creeping into all the European navies, viz., the Whitehead torpedo, they either ignore it, or say we have not had sufficient experience about torpedoes in warfare, or they are still very uncertain, but that probably they will be formidable weapons in a few years' time.

Now it seems to us that the time has arrived when the Whitehead torpedo should be considered in all manœuvres between ships, and its effect is undoubtedly to diminish the fear of being rammed, and to very much increase the danger of ramming another ship which is fitted with them; so much so that Commander Gallwey, one of our best authorities about Whitehead torpedoes, holds the opinion that no ship will attempt to ram another ship fitted with them. The Officers in favour of ramming may consider this too sanguine, but if they believe in Whitehead torpedoes at all, they must see the great danger a ship runs of being seriously damaged before she is able to ram the enemy.

We have attempted to show this in the following diagram (Plate X, No. I). The ship is intended to be the "Rupert," which is fitted with four Whitehead discharges, capable of training from 75° abaft or before to 10° before or abaft the beam. The dotted circles show the dangerous zones, where a ship is liable to be hit by a Whitehead torpedo.[1]

The only absolutely safe place to ram a ship like this is from right ahead, or from right astern; by a turn of the helm it would be perfectly easy to avoid it; this would also apply if attacking from ahead, only it is doubtful if a ship would dare move her helm if another ship were coming end-on at her, as directly the helm is moved the ship exposes her bow to be rammed.

[1] We have allowed 10° deflection when the carriages are trained either 10° before or abaft the beam.

If a ship missed ramming the "Rupert" and passed astern of her, as would probably be the case, she would be exposed to another torpedo being fired at her from her opposite quarter, at the same time showing a very large target at a short range, as is shown by the ship B in the diagram; the ship A is just coming into the dangerous position.

Ships that were fitted with torpedo discharges some years ago were either fitted with two or four discharges, but the carriages had a much more limited amount of training, very often only from 30° before to 15° abaft the beam, and allowing 10° deflection; the dangerous zone extends from 20° before to 25° abaft.

The diagram (No. II) represents a ship fitted with two of these discharges only, which would even prove a dangerous ship to ram, as the safest place to ram a ship is abaft the beam; this would compel a ship to pass through the dangerous zone.

Considering these two diagrams, it is apparent that the latter ship is not defended well enough with Whiteheads for an ironclad, but two discharges are very good for a corvette, and now most ironclads have four discharges, and, as we mentioned before, should have a bow and stern discharge as well, which would make a ship excessively dangerous to ram.

We have only been considering the Whitehead torpedo as a defence against being rammed, but by fitting the Whitehead torpedo to be discharged right ahead, it forms, besides being a very good defence, an excellent substitute for the ram and without one quarter of the danger, as ships so fitted would not attempt to ram, but would try and get an enemy to present as large a target as possible, and at a distance of 300 or 400 yards fire a torpedo from the tube right ahead, which if it hit would do the ship serious damage, and for the time probably demoralize the ship's company sufficiently to render ramming perfectly safe if it were thought necessary.

Therefore we hold that ramming is by no means the first weapon of offence, principally for the following reasons:—

1st. On account of the danger of being hit by a Whitehead torpedo.

2nd. As ramming is by no means successful the first time, and at each unsuccessful attempt, a ship runs a great risk of being either rammed or torpedoed.

From the experience gained in actual warfare and mentioned above, we find there were twenty attempts to ram, out of which only six were successful and totally destroyed the ships that were rammed, which means that 30 per cent. of the attempts to ram were successful. Now we unfortunately have no experience of torpedoes in actual warfare, except the few Whitehead attacks by the Russian boats against the Turks, and in one of the attacks they fired two Whitehead torpedoes at a revenue cutter which came in their way, and totally destroyed the cutter, which aroused the squadron, so that the boats had to beat a retreat. Hobart Pacha, we believe, denies this, but at all events the best evidence we have of the accuracy of Whitehead torpedoes is from the half-yearly reports of torpedo exercises of the Fleet.

Where a shot is considered successful, it strikes a ship of 200 feet long at 300 yards range.

In 1881, 80·2 per cent. of the shots fired were successful.
1882, 86·7 " " "
1883, 77·6 " " "

The percentage is lower in 1883, owing to the torpedo being fired in 97 cases over the range.

In 1883 nearly 1,000 shots were fired.

These figures point to the torpedo being accurate, and compare very favourably with the number of successful shots from guns.

In an action we could hardly expect 86 per cent. of the shots to be effective, as another error will come in, viz., the error in estimating the speed and course of the enemy, but even here a large error can be made, and still the ship will be hit.

For instance, if the speed of the torpedo be double the speed of the enemy, which it is, supposing the enemy to be steaming 10 knots, and now with the new torpedoes which travel 24 knots, the enemy might be steaming 12 knots.

Thus:—1. When the speed of the enemy is estimated correctly, a ship can be steering between 6 points outside her supposed course, and 2 points inside, and she would still be hit.

2. The speed can be over- or under-estimated as much as 2·5 knots.

3. If the speed be over-estimated, a ship can steer as much as 4 points outside her supposed course.

4. If the speed be under-estimated, a ship can steer as much as 3 points inside her supposed course. These give very broad limits for the great necessity for very great accuracy about the speed and course of the enemy, so we ought to make as nearly certain of hitting a ship in action as in hitting the target in peace-time, and probably we might consider that 50 per cent. of the shots would be effective at 300 yards range. Of course, as the distance increases the chances of a successful shot diminish, but 400 yards is considered a very good range to fire a Whitehead; outside of that it is not advisable to fire, if you think there will soon be a chance of getting a shot within the range, otherwise it is well worth trying up to 600 yards, its extreme range at present.

Having discussed the different advantages of the three weapons, we next have to decide which is the first weapon, and we are of the opinion that the introduction of the Whitehead torpedo has ousted the ram out of its former position, and given it the second place only, the gun at the same time becoming more on a level with the ram, as we hold that the ram will not often be used against ships which are properly fitted with Whitehead discharges; but the reason we have still placed it before the gun, is on account of its certain destruction to any ship it comes in contact with.

Where ships are not fitted with torpedoes, the ram still holds its old place, and the gun becomes relatively much inferior to it.

In any naval war we may be engaged in in the future, we are certain to have to fight ships provided with the Whitehead torpedo,

except at present with America, as all the principal European nations have armed their ships with torpedoes.

We have not mentioned any other offensive torpedoes, as the towing torpedo is practically abolished in all navies, the French being about the last to use it; also the spar torpedo on the broadside is abolished in our Service, although we believe the Americans still use it.

We will now discuss the different tactics that should be adopted, first in an action between single ships, and then in an action between two fleets.

An Action between single Ships.—1. We have assumed two ships meeting each other nearly end-on, having an equal speed of 10 knots, both ships having Whitehead discharges, but B having one right ahead as well, which A does not possess, B's right ahead Whitehead discharge being above water and clear of the ram.

B's tactics are to try and fire a Whitehead from right ahead, and if advisable to follow it up with the ram (No. III).

A tries to pass B at 600 yards distance, but B possessing the right ahead discharge, ports her helm and bears down towards A.

When A arrives at 3, if A knows that B has a right-ahead discharge, A should starboard her helm, and keep away from B, until at 6. A will be able to fire a Whitehead at B at 600 yards range, which should hit B at *b*, but B directly he sees the Whitehead fired should put his helm hard a-starboard, stop the engines or reverse one propeller (if fitted with twin screws); if this is done in time, the Whitehead will pass harmlessly ahead. A after firing the Whitehead, and seeing B turning towards him, should put his helm hard a-starboard and keep B bearing on his quarter, and if possible increase speed, so as to be able to manœuvre across B's bow, keeping out of range of his right-ahead discharge.

This is about his only chance of not being hit by B's torpedoes, as we have tried to show by the courses, &c. (in dotted lines). Thus if A when at 3 did not know B had a right-ahead discharge, and thought he would keep on his course, and cross B's bow sufficiently far ahead to prevent being rammed, when B arrived at 5, he could fire a torpedo at A at 330 yards range, A at the time showing his whole broadside, while A could at the same time also fire a torpedo at B, but B is only end-on.

If B fired his torpedo and A saw it, he should at once put his helm hard aport and stop the engines, if this were done in time the torpedo would pass harmlessly ahead of A, but if B at the same time as he discharged the torpedo righted his helm, he would be able to ram A just before the beam at 6.

If B, however, did not right his helm, and tried to pass ahead of A, or even if he kept his helm hard over, B would lose his advantage, and would be either rammed at B′, or would allow A to get within his circle, while he was outside of A's circle, so it is most important for B to follow up his advantage in this case by ramming A.

We will again attempt to show that A should make a running fight.

As suppose at 7 A tried to cross B's bow and fire another torpedo at her starboard side, directly B observed this, he should starboard his helm, and when he arrived at 9 fire a Whitehead from right ahead at 420 yards range, which would hit A at a', unless A turned as we mentioned before, B would probably be able to follow this up with a successful ram. In this case we have tried to show that a ship with a Whitehead discharge right ahead has a great advantage over another with Whitehead discharges on the beam only.

We have not yet mentioned when the guns should be fired or how. Many Officers consider it a mistake to open fire with the guns too early in an action, as they obscure the enemy and hide what his movements may be, besides firing beyond a certain distance becomes very uncertain. Therefore we would hardly recommend firing being commenced before the ships arrive at 3, when the ships are about 1,400 yards apart, and should be independent firing at first, broadside firing being reserved for when the ships pass fairly close to each other. We have not mentioned about torpedo-boats, with which in our days every ironclad is provided, or ought to be provided.

These boats should, if possible, be hoisted out, and kept under the off-quarter of their own ship, then when the enemy attempts to ram her, they should pounce out and fire a torpedo at her. No doubt they would get other opportunities under cover of the smoke of attacking the enemy, but it is useless to send a torpedo-boat, when there is no smoke, to attack a ship, as she is certain to be destroyed. It is very important to have them hoisted out, as if inboard they would be riddled with bullets, and thus rendered useless. In this and the following cases we have mentioned what a ship should do if she saw a torpedo coming towards her, but it must always be remembered, it will probably be only the exception when a ship will see a torpedo coming at her, at all events in time to be able to turn and avoid it.

2. We have assumed two ships of equal speed, as before, but B, instead of possessing a right-ahead discharge, has one right astern, both ships possess the ordinary broadside discharges, but cannot fire their torpedoes before 15° before the beam.

B's tactics will be to try and cross A's bow at a safe distance to prevent being rammed, and then to fire torpedoes at A from her beam and stern discharges, as shown in (No. IV, Fig. 1).

If A allowed this, B at B′ could fire a torpedo from his broadside discharge at 150 yards range, and from his stern discharge at 220 yards range, A each time presenting a very large target.

No doubt if A knew B had a stern discharge, or even only the broadside discharges, he would try and prevent B crossing his bow, and would probably starboard his helm, as shown in Fig. 2, and at 4, if B did not alter his course, he would be able to fire a Whitehead at B, which B would not have allowed, as at 2 he should have ported his helm, and tried to run a more or less parallel course, but keeping out of range of A's torpedoes.

A would have rather the advantage of the position, but if he tried

to close, and B kept edging away, he would lose it, without perhaps getting close enough for a shot.

In this case the action would be probably decided by the gun, without either ship went in for ramming, or one of the ships made a stern fight, which perhaps would be best for B, particularly if B has a good stern-fire, but it is doubtful if A would approach near enough for B to get a shot at her from her stern discharge.

3. We have considered an action between the "Polyphemus" steaming 16 knots and an ironclad steaming 12 knots with broadside Whitehead discharges only, but the carriages are able to train 75° before or abaft the beam (No. V).

The tactics the "Polyphemus" would probably adopt is to get within 600 yards of the ironclad, fire a torpedo from her submerged tube, and if possible ram her opponent afterwards.

The ironclad's tactics would be to make a running fight as long as possible, use her guns as much as possible to try and damage the "Polyphemus," which would be a very difficult undertaking, as end on she would be very difficult to hit. Then, when the "Polyphemus' was getting very close, to turn either way, and fire a torpedo from one of the after-carriages, and, if possible, afterwards to try and do the same with the other carriage; this would be the ironclad's only chance of escape, as the "Polyphemus" must overtake the ironclad, and will therefore be able to fire from her submerged tube, and ram the ironclad when she does overtake her. We have tried to show this in the diagram: we have imagined the "Polyphemus" has approached within 1,200 yards of the ironclad, about two minutes afterwards the "Polyphemus" will be only 900 yards directly astern, the ironclad starboards her helm, and at 3 fires a torpedo from her port after-carriage which should hit the "Polyphemus" at P'; the "Polyphemus" directly she saw the ironclad turn would probably be aware of the reason, and would be on the look-out for a torpedo being fired, and directly it is fired, the "Polyphemus" should turn towards it, and it would be comparatively easy to keep clear of it, as she would only have to turn a little before she would be out of the track of the torpedo. The ironclad should right her helm directly the torpedo was fired, and try if possible to fire a torpedo from her starboard after-carriage, but this is an impossibility, as if she tried to turn either at 4 or 5, she could not get the training on, so her only chance is to go straight on, and trust to her guns damaging the "Polyphemus's" engines; if not, at 7 or 8, the "Polyphemus" will be able to fire a torpedo from her submerged tube, and at 9 would ram the ironclad under the stern, without A exposed his quarter with the hopes of getting another shot, which he would hardly think of doing.

In the above case we think the "Polyphemus" would have much the best of an action with the ironclad, but supposing the ironclad has a right-astern discharge as well, the "Polyphemus" will find it very difficult to get within range if the ironclad made it a running fight, which no doubt should be her tactics.

No. VI is intended to show this; the "Polyphemus" is chasing the

ironclad, but should be careful not to get within range of A's stern or broadside discharges.

The "Polyphemus" will gain considerably, and if A allows her to approach just out of torpedo-range and get before her beam, the "Polyphemus" would have considerably the best position, as at any moment she could put her helm hard over, and turn towards A, fire her torpedo, and if she liked try and ram A, but we have hardly thought A would allow this case to happen.

But instead, A should, when the "Polyphemus" bears before a couple of points abaft the beam, turn away from her and steer a course immediately away from her; the "Polyphemus" would also turn, but would have to go through the same thing as before, that is, to try and get before A's beam, out of range of A's torpedoes, but when the "Polyphemus" got to about the same position, A should turn again, this could be repeated as many times as necessary, the "Polyphemus" being all the time absolutely harmless, while A could keep up a steady fire at her.

The "Polyphemus" could always withdraw from the action whenever she liked, but if the ironclad A adopted these tactics she could not harm the "Polyphemus."

Of course if the ironclad went in for ramming, the "Polyphemus" would soon get the best of the action, because of her superior speed and right-ahead discharge.

The "Scout" class could not keep up an action like this, as they are vulnerable above water, which will prevent them from being as useful as the "Polyphemus."

If these diagrams are correct, it would seem very advisable to fit right-astern discharges to our ironclads, as we recommended in the last chapter.

We have not considered an action between rams only, without any torpedo discharges, as they are hardly likely to be met with in any future war, and so many much more experienced Officers have fully discussed the different methods of fighting these actions, that it would be a mere repetition of their views.

An Action between Fleets.—This is an even more difficult subject than an action between single ships; as mentioned before we have no practical experience to guide us, and there are a great number of different ideas expressed by different Officers.

Some believe the gun is the first weapon in a fleet action, and that ramming will only be tried when an opportunity occurs; hardly anyone seems to have thought much about the place of the torpedo in a future fleet action, except, perhaps, the editor of the Battle of Port Said, where they are supposed to be used, and also numerous torpedo-boats; several of the ships are supposed to be destroyed by them.

The prevailing idea of a naval battle is two fleets charging at each other, using their guns, rams, and torpedoes as effectually as possible for the few seconds they are in contact, then re-forming and charging again, and so on.

But it seems questionable whether this method will always be adopted, now that torpedo-boats have come into use, and are attached

to all fleets. Might not these boats advantageously be sent under cover of a very heavy fire to throw the enemy's fleet into disorder, and possibly to destroy some of their ships? Then, having succeeded in their endeavour, the fleet might finish the required work. A fleet action seems particularly suitable for the use of torpedo-boats.

Next we want to know what order of formation to adopt for the fleet. Many Officers recommend line abreast, but it appears to us to be a bad formation for attack, as when the enemy's ships are passing through the line, if any of the projectiles which are intended to hit them do not, they will very probably hit one of the friendly ships.

The same also with their torpedoes, particularly if the ships are in close order, which they are usually supposed to be.

It is a difficult formation for ramming any of the enemy's ships, and is very extended.

Line ahead we think is a better formation than line abreast.

But we prefer the group formation to any of the other formations, as there is no chance of firing into one's friends, and there is a clear all-round fire from all the ships for both torpedoes and guns. It is besides a difficult formation to attack with the ram, and at the same time comparatively easy for either of the ships of a group to try and ram one of the enemy's ships.

The French peloton formation is recommended by some Officers, but it does not seem to be quite as good as our system of groups.

We have imagined two fleets of six ships steaming 10 knots meeting each other. Each fleet has hoisted out their torpedo-boats; we have assumed them to have nine torpedo-boats each.

One fleet, A, advances in groups (starboard group formation), No. 2 group forming in quarter line, A_4 being seven points abaft A_1 at six cables. The other fleet B advances in single column line ahead (No. VII).

A has his torpedo-boats in line ahead, while B has his under the off quarters of each of his ships.

We have imagined A to be trying to pass B's fleet at about four cables distance, and to engage the fleet with his guns, until when A gets nearly abreast of B, the torpedo-boats put their helms hard a-starboard together. The first four, with the intention of attacking B_1, turn through eight points, the other five do not turn so much (and should ease to pass under the others' stern), the 5th and 6th steer so as to attack B_2, while the last three boats steer so as to attack B_3, all the boats approach until they get within 300 yards, when if possible they should fire their Whiteheads, and we think it is very probable that B's 1st and 2nd ships would be most probably destroyed, as the boats would only be $1\frac{1}{2}$ minutes under fire, part of which time they would probably be hidden by the smoke; the 5th and 6th boats would be rather longer under fire, so they might probably be both destroyed before they could fire at the 3rd ship, B_3.

The destruction of B's two leading ships (if it is effected) would no doubt seriously throw the fleet into confusion, and A's ships should at once take advantage of it, by turning and attacking B's fleet at shorter range, and if possible ramming some of his ships.

The machine-guns' crews should be warned particularly to try and

destroy B's torpedo-boats. A's ship should use independent firing as they pass, so as to make as much smoke as possible to hide the movements of their boats.

We have not yet considered what steps B should take to prevent his ships being destroyed.

He might, to begin with, try to approach near enough to be able to turn and try and ram A's ships, and if he were determined to have a closer action A could not well prevent it, but in this case the torpedo-boats should divide into two parts, each part protecting one group, and if B's ships try to ram, the torpedo-boats could turn and fire Whiteheads at them; A's ships trying to avoid being rammed, and at the same time trying to ram B's ships.

Or he might proceed, as we have shown in the diagram, with his boats under the off-quarters of the ships. Directly he saw A's boats coming towards his ships, he could send his boats to try and destroy them, but it is doubtful if they could do much in the $1\frac{1}{2}$ minutes, or he could turn together eight points to starboard, and thus show a smaller target and keep the boats longer under fire; this would seem to be the best, but even then the ships would not be able to go far before the boats would be able to fire their torpedoes at them. If these tactics were adopted by A, and B allowed them, we think A would be considerably the gainer, and much more so than if A's fleet charged B's, when directly the fleets meet, each fleet stands the same chance of losing ships, while in this case A has succeeded in destroying two out of B's six ships, and probably also has damaged some of B's torpedo-boats, whereas he has only lost some of his own torpedo-boats.

The damage done by the guns of the fleet will probably be about the same, and will depend on the training of the men, and the quality, size, and number of the guns.

2. If B's fleet, however, had been in line abreast (No. VIII), A could not have carried out these tactics so advantageously, and probably would not have wanted to do so, as this being an easy formation to attack directly, he would no doubt try that method in preference, and would form his fleet into groups in line ahead, dividing his torpedo-boats into two parts, one part being attached to each group, and stationed under the stern of the leader of the group, with orders that each part is to act together and go and attack the nearest ship, which the ships are not attacking, or not able to destroy. He would steer so as to pierce B's line towards one end, B could not easily prevent this, as if his fleet altered course together, A, having a much smaller front, could alter course also, and pierce the line at the point he wished, B's ships besides being in a bad position to prevent being rammed by A's ships, as they show their broadsides. Therefore, B's fleet would probably not try to prevent A's ships piercing his line where A wished. A's fleet are in a very good formation to prevent being rammed, while B's fleet are easy to ram, and in a bad formation to try and ram A's ships.

A would, therefore, make up his mind to adopt ramming tactics. It should be remembered that this is a different case to a single ship

action, so whenever two fleets charge each other, they must pass within range of the Whitehead torpedo, therefore ramming is not more dangerous than simple charging, as far as the torpedo is concerned, besides being always preferable to act on the offensive, if possible.

Therefore, in the diagram we have shown A's fleet trying to pierce B's line between B_2 and B_3.

A_1, when he gets within ramming distance, turns to port to try and ram B_2, A_2 and A_3 turning the same way but using less helm; B_2 directly he sees A_1 turn, should turn also to avoid being rammed, as if he went on he should be rammed at *a*. B_2 should starboard his helm, and about the best thing he can do is to steer so as to meet A_2 end-on, as if he puts his helm hard over, A_2 has only got to ease his helm, and will ram him on the beam, also if B_2 turns to starboard, A_3 will be able to ram him.

The torpedo-boats of the first group should be told off to go and attack B_1, and ought to be able to destroy him, A_3 engaging him with his port guns and torpedoes. A_4, the leader of the second group, when he arrives at 1, should turn to starboard so as to try and ram B_3, A_5 having also at the same time to try and prevent B_3 evading A_4's ram. If B_3 goes straight on he will be rammed at *b*. If he puts his helm hard a-starboard, he will escape being rammed by either ship, but if he puts his helm over less, he will be rammed at *b'* by A_5, but should he escape these ships' rams, the torpedo-boats of the second group should be able to settle him.

We have not given A_6 anything particular to do, but he might go straight on, in case B_3 turns to starboard, and then he would get a chance of ramming B_3, A_6 would also engage B_1 with his port guns and torpedoes.

B has kept his torpedo-boats under his ships' quarters where they would be told to remain, except another ship attempted to ram their ship, when they should go full speed ahead, and try and destroy her; they might be able to destroy one of A's ships, but not being together they are liable to be sunk before they are able to do any damage.

A's ships should have destroyed three of B's ships B_1, B_2, B_3, but probably might have lost A_2, if she met B_2 end-on, and if one of B's boats are fortunate, another of A's ships might be destroyed, therefore B would have lost three ships, while A, perhaps, has lost two, but probably only one; B's other three ships have been no use to him at all, while A's ships have all been useful, which is one of the disadvantages of line abreast.

As the fleets are approaching, B's bow fire will be more powerful than A's, but until the fleets are about 2,000 yards apart, it is not of much good beginning firing, as the smoke hides what the enemy is doing, and does not do much good. When the ships approach, concentrated broadsides should be used, and every opportunity taken of firing Whitehead torpedoes.

After the fleets pass clear of each other after the first charge, they should reform as quickly as possible and charge again, any torpedo-

boats that are left should attack any disabled ships. B would most probably possess more of these boats and would have a slight advantage, but A ought to be able to look after their disabled ship or ships.

If B's fleet had been in any other formation than line abreast, we believe it would be for A to adopt similar tactics to those he adopted when B was in line ahead.

We have not space to consider all the different formations B might have been in, but have attempted by these two fundamental formations to show how A should attack them, using somewhat similar tactics for the others. We would always recommend our fleets to fight in groups, arranged in different ways according to what formation the enemy is in.

The torpedo-boats, if it is intended to act on the offensive, should be always kept together, as we have shown for A's torpedo-boats, but if the fleet is outnumbered and acting on the defensive, they should be kept on the quarters of each ship, as B has arranged for his boats. We have not yet discussed the position of the torpedo rams of a fleet, and it is very difficult to give them a position, but if they have great speed it would probably be better to leave them to act independently and to bring up the rear of the fleet, so as to be able to finish up any disabled ships, and to attack the fleet again while they are re-forming. If they have not very great speed, they had better take their place in the group, either as second or third ship; it would not do to make them first ship, as they have no guns.

We will next consider the duties of a fleet blockading an enemy's coast.

A blockading fleet would have to be composed of more ships than the enemy has in the harbour, otherwise it would be easy to raise the blockade any day that the defenders liked. It would have to be provided with plenty of torpedo-boats and torpedo-boat catchers, besides it would require torpedo depôt ships to take charge of these boats, and also colliers which are able to coal the ships outside the harbour, without there were a well-protected harbour close at hand, like the Federal ships which were blocking Charleston had at Port Royal, only 60 miles from other former places, otherwise they could not have kept nearly such an efficient blockade. It will be very difficult in these days to maintain a blockade good enough to prevent some of the defender's ships escaping; but it will be very easy in most places to drop mechanical mines across the entrance, with the hope of destroying any ships which try to escape. These mines should be dropped at night, in order to prevent the defenders knowing their positions, and if it is known that the enemy have destroyed any, another line can easily be dropped outside the first.

If mechanical mines could be dropped outside all the enemy's harbours without his knowledge, they would probably prove very effective, and should be tried in any future war, as at worst it would delay the enemy's ships whilst a passage was being cleared, and our ships are not nearly numerous enough to blockade many of an enemy's harbours.

The fleet would probably be divided into two squadrons, an inshore and outside squadron. The inshore squadron being composed of fast cruizers, they would act as the scouts of the ironclads, and should be stationed outside the mouth of the harbour, and outside the range of their guns, so as to form a cordon of ships across the mouth, but if there were not many, or it was a very broad mouth, they would have to steam slowly across, otherwise they might remain stationary, at intervals near enough to prevent any ship passing out unobserved.

They should show no lights at night, and have some distinguishing mark to prevent them being mistaken for the enemy.

The outside squadron should be composed of ironclads, and should be kept more together, to be ready at any moment to attack the enemy's fleet, in case it should attempt to come out. They might steam slowly across the entrance at night, at some distance to seaward, but within signalling distance of the inshore squadron, who should signal to tell them of any ship coming out of the harbour, the outside squadron indicating their position if necessary.

The torpedo-boats and torpedo-catchers would steam about inside the inshore squadron, and would be on the look-out to prevent the enemy's torpedo-boats coming out to attack the inshore squadron; some might be sent to patrol the entrances of any harbours which are close at hand, so as to prevent torpedo-boats being sent out to attack the fleet.

They should signal by firing rockets or some other preconcerted signal, when they observe any of the enemy's torpedo-boats approaching. The torpedo-boats should always be given a new password every night, and great care should be taken to prevent the enemy's torpedo-boats passing themselves off as friends; this will be a great danger in any future war.

If any of the defender's ships try to escape, the nearest fast cruizer should at once proceed in chase, and if it is an ironclad, she should at once signal for an ironclad from the outside squadron, or better still a fast torpedo-ram like the "Polyphemus," if there are any available.

Attack of Ships at Anchor by Torpedo-boats:—The great thing in all torpedo-boat attack, is to use plenty of fast boats and that they should be well drilled at keeping station, or reaching the enemy's ship simultaneously.

Before making any attack it is advisable to know as much as possible about how the enemy's ships are defended and if there are any defences arranged for the harbour, such as a boom or boat mines, also if the ship is provided with the electric light, if so, everything must be painted black in the boats, and also the boats themselves.

If there is a boom across the entrance of the harbour, it is no use sending torpedo or picket-boats in to attack the ships until it is destroyed, and as it cannot be destroyed without exploding a charge, which would alarm the fleet, it would be useless to send the boats in immediately after the boom was destroyed, and the boom would be repaired before the next night.

If boat mines are supposed to be used, boats should be warned to

keep clear of any floating objects, and no doubt if efficiently fitted and placed they would prove very dangerous to attacking boats.

If the ships were known to be defended by wire torpedo-nets, it would be of very little use to send boats armed with Whitehead torpedoes against the ship, except on the off chance of one of these torpedoes penetrating the net, or its possible explosion on striking the net, damaging a ship.

So in this case we have to look round for some arrangement to fire a charge inside the net, and between it and the ship's side. An outrigger torpedo on this principle is being tried on board the "Vernon," and all boats should be fitted with an outrigger torpedo, on this or a similar principle, instead of the present Service outrigger fittings; besides boats should only carry one spar instead of two, so if required they may carry Whitehead torpedoes as well.

These are about the only boats that could be used in attacking ships defended with nets. If there is a boom as well, steam pinnaces can only be used with the false cutwater shipped on the stem.

If the attack is at all feasible, all the steam pinnaces, &c., belonging to the fleet should be used so as to have at least four for each large ship in the defending squadron if they are only three, or if more, three boats for each ship only would be required. The attack should be concentrated on the two handiest ships, as if it is split up too much, most probably no damage will be done to the fleet.

The boats should go in in two lines, the rear boats being armed with their machine-guns as well, to drive off the guard boats if necessary.

They should be well practised in keeping station, and should go in slowly so as to prevent being discovered, show no sparks from their funnels, and if possible keep under the shadow of any high land. When getting close to the boom they must go full speed at it, and after jumping it go on straight for the doomed ships, run at the nets end-on and drop their spar and torpedo over them, fire their torpedoes, and go full speed astern and make their escape as soon as possible. If the ships are using their electric light and throwing the beam about in different directions, after jumping the boom they should spread out; but if the ships are surrounded by a beam of light, some of the boats should be specially told off to attack the vessel or vessels burning the light, and if they succeed in destroying her, they might get a chance of attacking the other ships more easily.

But a fleet thoroughly well defended first by a boom with boat mines outside it, and coir hawsers, &c., to foul the boats' propellers—the boom probably lighted up by a beam of light, and a heavy machine-gun fire laid for the boom—besides all the ships defended with nets, is by no means an easy task and requires a considerable sacrifice of boats and lives, which may not be always sufficiently repaid by the results obtained. If, however, there is no boom or the ships are not defended by nets, the torpedo-boats would have much the best of it; no doubt the nets are the most efficient protection a ship can have at present, and every ship should be supplied with them. If there were no boom, torpedo-boats could be used, but if the ships are known to

be defended by nets, with their Whitehead torpedoes they cannot do much good, without an unsinkable gunboat could be used to ram the defences and carry them away, after which the torpedo-boats would be useful. They would make excellent boats for the outrigger torpedo for dropping over the nets, on account of their great speed, as compared with steam pinnaces, which are only fitted with the outrigger.

But the torpedo-boats, &c., could be sent about to make false attacks and to harass the defenders.

Where torpedo-boats will really prove themselves of use will be in the attack of ships off the entrance of a harbour.

The defenders could make excellent use of their boats in this way, going out and trying to take some of the ships of the blockading fleet unawares, and if discovered too soon, they need not force their attack, without they wish it; they would prove most harassing to the blockading fleet, who would have to trust to their machine-guns and their electric light, without they had their nets very well fitted, and able to get them clear of the water very quickly in case they had to chase a ship; this no doubt will be obtained very soon, but in rough weather it is doubtful if any net defence will ever be arranged so that it will stand the ship rolling about much.

Therefore on rough nights these attacks should be made, and if it were too rough to fire a Whitehead, outrigger boats might be used. The torpedo-boats should go out in two lines, steaming slowly, and trying in every way not to be discovered too soon; but directly they are found out by a ship, to steam straight at her at full speed. The ship if she had no nets out, or could not keep them in place, would no doubt adopt her best mode of defence, that is, to make a running fight, thus keeping the boats longer under fire, in the hopes of destroying them. If she had nets out, she could steam slowly, or better perhaps remain stationary, turning if necessary to bring her guns to bear on any of the boats.

These torpedo-boat attacks would be an excellent way of driving the inshore blockading squadron away, particularly if any ship wished to run through the blockading fleet; they will besides all help to make blockading an enemy's harbour more difficult.

This brings the chapter to a close. As we have discussed the defence of ships at anchor in the next chapter, we will not repeat it in this chapter.

Chapter IV.—*Attack and Defence of Harbours.*

This chapter may be divided into two parts. We will first consider the defence of our own harbours and next the attack of an enemy's harbour.

Now owing to the changes brought about by the introduction of steam, and lately by fast torpedo-boats, any night after the declaration of war with a naval Power, we may expect to find some of the enemy's torpedo-boats trying to enter some of our many harbours, and if not prevented, going round destroying the shipping in the harbour; or

there is a chance of some of the enemy's cruizers appearing off our numerous seaside towns, and levying a large sum of money under threat of bombardment. These are two of the kind of dangers our seaports are exposed to which have to be guarded against, and the question which has of late been much before the public is how to prevent these occurrences; this we will now consider.

Our seaports are divided into two kinds, viz., military and commercial ports.

The military ports are such ports as are considered of sufficient strategical importance to defend and make as secure as possible; there are nine of these ports, viz., Portsmouth, Plymouth, Portland, Pembroke, Sheerness, Chatham, Dover, Harwich, and Cork.

These ports are defended by forts, and have a complete submarine mine defence arranged, and are supposed to have the men and material to lay them down; but, however, as no torpedo-boats or gunboats are actually told off for their defence, but as five of these ports have dockyards, there would probably be some ships in the harbour in case of an attack; the other four, however, are without any vessels at all.

It would seem desirable that each of our military ports should have a certain number of torpedo-boats told off for the defence of the port and surroundings only, and not on any account to be allowed to be taken away very far from the port. We would recommend that Portsmouth and Plymouth should each have five boats, and each of the other ports have three boats, which would require thirty-one torpedo-boats for our military ports, and which would add considerably to their defence. Gunboats are not so necessary for these ports, particularly if they are well defended by forts.

The forts for these places are nearly all complete, but many of the guns have never been fired in position, generally because they point towards the town, or some houses; therefore, when these guns may be required to be fired in actual warfare no doubt defects will show themselves, perhaps sufficient to disable the guns during a critical period, as was clearly shown at the bombardment of Alexandria, where many of the guns were disabled through defects of mounting. It would seem advisable that some practical tests should be tried, and perhaps in many places they could be fired with case shot, the guns being well depressed, so as to prevent any chance of the bullets doing any damage; this, if it were done once a year, would be a fairly satisfactory test of the fittings, &c.

The submarine mine defence should be of a kind that it can be quickly laid, easily kept in order, be in such a position as to be well defended by the guns of the fort, and not interfere more than necessary with the navigation of the port.

A defence to be quickly laid should be very simple, and the men should be drilled to lay it down against time. Now it is a matter of doubt to many whether the system adopted by the Royal Engineers answers these conditions: it is, first of all, very complicated, and having relays, &c., in the mines, which alone take time to adjust, it is very questionable whether it can be laid down quick enough for our

requirements; so much so that the Naval Torpedo School used to use relays, but have given them up, principally on account of their being complicated, and we adopt a much simpler system, not having any relay in the mine which is very liable to get out of order; even some Officers consider our system now is hardly quick enough to manipulate, and would adopt only the most simple mines, viz., mines fired by observation. The Royal Engineers are very much handicapped as regards the number of men, only having a few men at each place, but the Militia are supposed to help them, and we believe the Navy also if possible. It always appears rather inconsistent leaving the submarine defence of our ports to the Army, as it is so particularly a seaman's business, that one wonders why the Navy have not charge of the submarine mine defences.

Nearly all of the European nations leave the torpedo defences to their navies.

The Germans have arranged a very perfect system of closing their harbours; they use electro-mechanical mines, which would not be suitable for our harbours, as they close their harbours completely except a narrow passage; but they can lay all their mines in less than twenty-four hours, which is a great deal quicker than we can defend our harbours.

Some of our military ports might have a boom across the entrance, particularly at night, and should have an electric light placed close to it, in order that the beam might be thrown along the boom; this would no doubt prevent a great number of night attacks with boats, which otherwise would be possible, because torpedo-boats are unable to jump a boom, so that steam pinnaces and launches only could be used; and if the light were well placed, it would be difficult to place a charge on the boom in order to destroy it, if any boat failed to jump the boom, it would be certain destruction.

We next come to the second class of ports, viz., the commercial ports, which till quite recently were totally undefended, and no one appeared to mind whether they were defended or not; but thanks to our neighbours on the opposite side of the Channel writing numerous articles in their papers "about how, if they were at war with us, they would send cruizers to extort money, under threat of bombardment, from many of our unprotected seaports," and the late war scare have removed this apathy for a time, and now some of our large seaport towns are willing to subscribe money, and raise volunteers for their own defence, and the Government has held out promises of a certain amount of help, and are going to supply mines for the defences of the Mersey, the Clyde, the Severn, the Tyne, and have allowed the usual capitation grant, &c., for a company of engineer volunteers at each of these places, and perhaps, if these are successful, the number of places will be increased. At present the Government have not promised to provide torpedo-boats for any places; but it seems to us that another danger has not been thought of, which these boats would be able to prevent, that is, the danger of an invasion, and if it can be shown that they are necessary to prevent an invasion of this country, it would certainly be one of the duties of the Government to provide them.

Most Englishmen hardly give the idea of an invasion a second thought unless there is a scare, which seem to recur at different times, but at the present time, since the introduction of steam and the increase in all the foreign navies, while ours has been allowed to remain about the same, so much so that many persons consider the French Navy nearly equal to our own, it becomes a matter of importance to take some means to prevent the possibility of an invasion. When even in the days of sailing ships Napoleon only wanted command of the Channel for one day—and he said he would be in London on the fifth day—less would now be required in these days of steam.

We recommend torpedo-boats as a very cheap and effective way of protecting a long coast line; and they will also help partly in the defence of our commercial ports. Perhaps we might draw a rough imaginary picture of an invasion to explain the use of torpedo-boats. We will suppose an enemy, say the French, have been preparing for an invasion for some time and have concentrated their fleet, a number of transports, troop-boats, barges, and every conceivable craft that is able to be towed across the Channel on a fairly fine day—the French fleet having either inflicted a severe defeat on our fleet, or attracted them away—the transports and the ships left behind to convoy them would at present find nothing to oppose them until they attempted to land. We will not discuss whether they would be able to land, which is a military question, and depends very much on the number of troops we are able to concentrate on any part of the coast in a certain time. Now the duty for the ships or torpedo-boats (if there are any) for the coast defence, is to harass and destroy the transports before the troops have time to land; this duty torpedo-boats ought to do very well, as directly the fleet was sighted off our coast, the coast-guard look-out should telegraph to the nearest ports for torpedo-boats, these boats should always be kept in readiness, and would be able to start off nearly at once, and ought soon to reach the place of disembarkation, where, if they did their duty, before the troops would be able to effect a landing several of the transports ought to be at the bottom; the transports' only means of defence being the ironclads. These would find it very difficult to defend a large fleet of transports against a torpedo-boat attack, besides, the fire of the ironclads would be required to drive away the opposing force, and the transports would mask their fire to a great extent, without they were anchored rather carefully.

For this reason we think that torpedo-boats are much wanted, and should be supplied by the Government, coast defence gun-vessels would be also very useful to support them; these would also be useful for some of the commercial ports.

We next come to consider what system of defence the Government might be expected to provide, and what should be left to the seaport towns to pay for. A certain number of boats and *matériel* should be provided for each place according to its size and importance by the Government, and the men should be raised in the seaport towns to man them, and be incorporated as volunteers receiving the usual capitation grant, and if any place does not consider it has sufficient

defence they should be allowed to subscribe for more boats; but at the same time they would have to enlist more volunteers to man them, and should be expected to maintain the boats in repair.

The next thing we have to think about is how many boats each place should have, and whether some places could not be defended with forts and a submarine mine defence, or gun-vessels and a mine defence, or whether many of the tug-boats and launches could not have fittings put into them in time of war (which should be kept in store in the port), so as to be able to use the boat either for the Whitehead or spar torpedo.

We should recommend that each port should have a certain number of fast torpedo-boats and fittings for small tug-boats, varying according to the size and importance of the place. Also that certain important ports besides should have a gun-vessel stationed, specially for the defence of the port, and other more important ports should have a submarine mine defence, protected by shore batteries if possible, or otherwise by one or two gun-vessels.

The following table (p. 409) is drawn out to show the least number of gun and torpedo-boats that are required for the defence of each place, and which ports should have a submarine mine defence as well.

The following smaller ports also require torpedo-boats, and should have one boat stationed at each port, viz.:—

Yarmouth, Lowestoft, the Tay, Aberdeen, Wick, Thurso, Ramsgate, Rye, Littlehampton, Poole, Dartmouth, Wexford, Waterford, Kinsale, and Galway.

Some of these ports which own tug-boats might have outrigger fittings supplied for them.

We have allowed for the five most important places to be defended by submarine mines, these places should have shore batteries as well. We should recommend that the submarine mine defence should be as scattered as possible; these places being a few miles inland, it might easily be managed—one defence near the mouth of the river, another a little way further up, and so on according to the amount of material and men available; the main defence need only be commanded by batteries, the others might be more or less protected by boats. The navigation of the port must be in no way interfered with, therefore observation mines are the best to use, and as they do not require any internal mechanism which is liable to get out of order, they are doubly suitable. We would recommend them to be fired in lines of three mines, one observing and firing station combined being used for each defence if it does not consist of more than three or four lines, and of more than two stations. The rivers being narrow, a ship could hardly be able to get past the lines without being observed, but during foggy weather, as an additional precaution, a steam-launch might be told off to patrol outside the lines, and could give timely warning of an enemy's approach by signalling with her steam-whistle, or if a stationary boat were used, it could be joined to the shore with a wire and telephone, &c., or another method which might be adopted in foggy weather, is to stretch a coir hawser across the entrance (when it is not very broad), one end being brought close to the firing station,

The Population, Commerce, and Tonnage of Ships is taken from Sir Charles Nugent's Lecture in 1885 at the Institution.

United Kingdom.	Population, 35,262,762.	Commerce £694,105,264.	Tonnage, 98,773,156.	Number of torpedo-boats.	Submarine mines.	Coast-defence vessels.	Number of sets of fittings for tug-boats, &c.
		£					
London	4,766,661	198,291,323	15,142,223	5 1st class.	Yes; to be laid at different parts of the river.	3	6
Liverpool	552,508	195,863,002	13,258,076	4 ,,	Yes.	2	6
The Humber	111,549	53,935,573	4,695,479	3 ,,	No.	1	3
The Clyde	586,431	29,854,134	6,033,116	4 ,,	Yes.	2	6
Southampton	60,051	16,845,806	2,168,296	Defended	by its proximity to Ports	mouth.	
The Forth	..	14,367,809	2,364,237	3 1st class.	No.	2	3
The Tyne Ports	275,287	11,197,542	7,573,010	3 ,,	Yes.	1	3
The Tees	121,476	9,863,673	2,561,808	3 ,,	No.	1	3
Bristol	206,874	9,128,550	1,695,877	2 ,,	Yes.	2	2
Cardiff	82,761	6,102,493	5,046,709	2 ,,	No.		2
Swansea	65,597	3,087,361	1,701,244	2 ,,	,,	2	3
Dublin	273,064	3,072,361	2,840,326	3 ,,	Yes.	2	3
Belfast	207,671	2,752,505	3,000,740	3 ,,	No.	1	3
Sunderland	116,542	1,274,111	2,750,857	3 ,,	,,	..	3
Folkestone	..	11,539,621	396,793	1 ,,	,,	..	3
Newhaven	..	9,355,164	354,426	1 ,,	,,		
			Total	42 ,,	6 places defended by mines.	19 vessels.	52 sets of fittings.

and if any great strain is brought on the hawser, or if the hawser parts, it is certain that a ship is running past; and if the hawser be laid just in advance of the outer line, all that has to be done is to fire the line when this occurs.

Another method is to lay one or two lines of dormant mines in advance of the other mines, and during foggy weather to blow them up close to the surface, then if any ship bumps them, she will be blown up; this method necessitates (at present) the mines to be weighed and relaid again after each fog, which is a great disadvantage; besides if resorted to only, observation mines are wasted during foggy weather.

The gun-vessels we should recommend are those we recommended in Chapter II for coast defence, as they would be able to go outside in rough weather and carry a heavy gun, though the present type of gunboat, like the "Bloodhound," will do for some places where, to prevent the town being bombarded, it would not be necessary to go outside, as they are bad sea-boats.

The torpedo-boats should be the best that can be obtained, handy in turning, and not larger than the "Childers" type (113 feet long), although in some places with narrow entrances, &c., wooden torpedo-boats would answer better; but they are hardly good enough boats for defending the coast, whereas the "Childers" type are very good sea-boats, therefore, if available, they should be used.

The fittings for the boats should be principally for outrigger torpedoes, and if there are enough Whitehead torpedoes available, a certain number of sets of dropping gear might be sent to the principal ports, but on the whole we would recommend the outrigger for these tug-boats, as the men would want comparatively little training.

This idea has never yet been tried, but seems well worth trying, considering the large number of tugs, &c., available at our seaports, and it is important that during peace-time it should be practically tried, by fitting one or two typical boats with the gear, and trying whether they are able to stand the explosion of the charge, &c.

We next come to the training of the men, and what kind of men we should encourage to volunteer to man the boats.

First.—Each place should raise the number of men required to man the boats allotted to it.

Second.—They should all be seafaring men if possible, and should be entirely under the Navy. A Captain in the Navy and one or two Torpedo-Lieutenants should be appointed to organize and superintend the different corps.

A certain number of men might be sent to the "Vernon" every year to be trained for their particular work, receiving the same allowances as volunteers do when in camp.

The men intended for the outrigger boats should learn only how to use the outrigger, and be able to fit and fire the charge with safety—for which a fifteen days' course would be sufficient, and allow time for a good amount of time to be devoted to making dummy attacks singly, and in company with other boats.

The men intended for the Whitehead boats should have a longer course of thirty days (if possible), part of the time being devoted to instruction in handling the boats.

The artificers, who would be required to take charge of the torpedoes, would require a longer course, besides learning how to work the engines of a torpedo-boat.

The stokers should if possible be sent for a course in working the boats, so that when the boats arrive at the different ports, the crews will have all been trained in their particular work.

We have not yet mentioned the Officers; there ought not to be any difficulty in obtaining any number of gentlemen who are fond of yachting, to volunteer to take charge of the boats, or if possible retired naval or merchant service Officers might be obtained, which would be of course better. The Officers would require the same length of course as the men, except those intended for the Whitehead boats, who ought to be thoroughly acquainted with the particular pattern of torpedo they are going to be provided with; if possible, each place should have torpedoes of the same pattern; this is every day becoming more important on account of the many different kinds of torpedoes which are being made.

There ought at least to be one spare crew for every three boats, to form a relief crew and to fill up casualties, as every night at least one boat would be required for patrolling; this will prove very arduous work during our next war.

The men and Officers should be exercised in the torpedo-boats at certain fixed times during the year, and the crews for the outrigger boats should also be drilled, but special arrangements would have to be made about the latter crews, as they would only have their boats fitted during war-time, as a harbour service steam pinnace might be lent to each port for drill purposes.

These crews might be enrolled in a corps similar to the Naval Artillery Volunteers, only with more branches, and might appropriately be called the Naval Torpedo Volunteers.

The crews for the gunboats would be drawn from the Naval Artillery Volunteers, extra branches having to be formed at the places where none exist at present, the men being trained on board the "Excellent."

The men for the submarine mine defence are being enlisted at four of the principal places, and will be under the Royal Engineers, which seems open to the same objections as we mentioned before.

Defence of Coaling Stations.

The defence of our coaling stations is our next consideration. Money is being voted for the erection of shore batteries at these vulnerable and important points, but at present no coast defence vessels or torpedo-boats are stationed at any of these places, except Malta, Gibraltar, Hong Kong, and the Cape, but their numbers even at these places are not sufficient.

Four first class torpedo-boats at least are absolutely necessary at

most of the coaling stations and one or two coast defence gun-vessels, besides a complete submarine mine defence.

Everyone owns that the coaling stations are of great strategic value and should on no account be allowed to fall into an enemy's hands; an enemy should not be allowed even to approach near enough to be able to shell the coal stores. One can easily imagine the position of a fleet with hardly any coal left, making for one of the coaling stations to replenish and finding it either in the enemy's hands, or that the enemy had set the coal stores on fire. Besides the loss of a coaling station would give the enemy's cruizers a safe haven to start from and prey on our commerce, as they are generally situated close to the principal lines of traffic. The men to man the boats might at some of the stations be volunteers, raised in the place, but at others blue-jackets would have to be sent out from England.

Besides the harbours mentioned above, there are others where a fleet or single ship might have to take refuge in the face of a superior force, which it would be imperative to defend.

If the ship or fleet were closely followed by the enemy, one of the quickest ways to block the entrance is to drop electro-mechanical mines across the entrance of the harbour; these, with the automatic depth adjusting arrangement invented by Lieutenant Ottley, could be dropped by the ships as they enter the harbour, and would take up their proper depth, without any necessity of soundings being taken.

But if the ships were not very closely followed by the enemy, it would be preferable to lay out electrical mines, and defend them by the guns of the ship. To enable this to be carried out, the ship or ships should be anchored opposite the entrance, and should either have a spring on their cables, or be moored head and stern, so as to have their broadsides bearing on the mine field.

If only one ship is seeking refuge, at present during war-time she will be provided with twelve observation mines and six E.C. mines, which would not make a very good defence; but we hope that more E.C. mines will in future be carried by our large ships; with casks more E.C. mines might be extemporised.

The mines would be laid across the entrance, the observation mines being laid in the deepest channel, and near where the firing and converging station is intended to be, the E.C. mines being laid in the other part of the channel.

The cables should be brought into the firing station, which should be erected in a place which is easy to defend, and should also be used for converging the lines of observation mines on. The field guns and a certain number of men should be landed to defend the station.

A boom might be made to defend the entrance if there is time, but it is by no means a necessity.

The ship should be well defended by nets if securely moored, might be surrounded by boat mines, and coir hawsers might be stretched round the ship as well, in order to foul the screws of steam-boats.

If time permits, dummy cables should be laid in advance of the real cables, to prevent them being destroyed.

Guard-boats should be used, but on no account allowed to approach within a certain distance of the ship, and not allowed to come alongside on any account after dark. They might fly white ensigns to distinguish them from the enemy's boats.

If a fleet had taken refuge, a more elaborate defence might be devised; the firing station taken more to the rear and a separate converging station should be used. The torpedo depôt ship would prove most valuable, and would be able to supply the extra cable and gear required.

We would not recommend mechanical or electro-mechanical mines being used for the defence of the entrance; but in case there were two entrances, one could be very easily completely blocked with these mines, which would not want so much trouble being taken to defend them, besides being much quicker laid.

The main entrance should be defended with observation and E.C. mines, and each entrance should have one or two lines of boat mines laid across the entrance.

The defence of the mine field might be left to the boats of the fleet, as an ironclad or gunboat anchored near the mouth of the harbour would be very liable to be attacked; the boats would, however, have to be very careful not to cross the line of boat mines. If there are any positions on shore near the mouth of the harbour, it might be worth while to land some of the field-guns from the fleet, leaving the others to be landed to defend the firing station.

A boom might be laid across the entrance if time permits; if so, the boat mines should be laid just in advance of it, and whenever a boom is made, it is advisable to make it double, as it is more likely to be effective in stopping boats, the booms being placed about 30 feet apart.

The next thing we have to consider is how we are to anchor the fleet, in order that the ships can best resist a torpedo-boat attack.

Opinions differ on this important point, and it seems that we have hardly tested any of the various methods, as very often when a torpedo attack is arranged, the positions of the ships are not altered, and as they are anchored as usual in peace-time, no method is tried of how to anchor the fleet to the best advantage.

Very often six or eight boats are sent away to attack a fleet of perhaps seven or eight ironclads, and many Officers seem often surprised that the boats do not succeed in destroying one or more of the ships; this, of course, gives a false impression of the danger of a torpedo attack, and one is led to believe they are not as dangerous as they really are; but the real question is, would any Admiral during war-time ever think of sending six or eight boats to attack a fleet of ironclads? Of course if he really intended to make an attack, he would not think of sending such a small number in, and would wait until he got a larger number together, although he might harass the enemy considerably with these few boats.

We would recommend our ships to be anchored as close as possible together, and to form themselves either into two lines or a square, as shown in the diagrams (IX, X), according to the number of ships,

the line of bearing to anchor on being the direction of the prevailing wind; when the ships are anchored, they might before dark each night, run out a wire hawser from the stern of one ship to the bow of the next, and have the wire sufficiently taut and low down so as to catch the upper part of the stern, or the funnel of any boat trying to pass between the ships. This, if not expected, would disorganize a boat's crew for the time, and if guard boats were on the alert just inside the hawsers, they ought to succeed in capturing the torpedo-boats that try to pass between the ships.

We have shown also in the diagrams how the electric light should be used.

It has been found in different attacks that indiscriminate use of the electric light is worse than useless, so we recommend that the fleet should be surrounded by a beam of light, which would require four projectors. These might either be obtained by using two ironclads or four gunboats; we would strongly recommend the four gunboats, as they are much more difficult to destroy, as they offer a much smaller target and do not draw so much water, and can be easily defended with nets, and, if considered necessary, with a row of boat mines round them. If these are used they should be moored head and stern, although, if possible, they should be moored head and stern either way, as this will prevent any torpedo being dragged under their bottom. These gunboats should be anchored in échelon, so as to bring all their guns into play, and should be completely surrounded with nets. In some harbours where there is only one narrow entrance, a gunboat or even two gunboats anchored near the mouth and close inshore could throw a beam of light across the mouth, and some of the ships could be anchored fairly close so as to bring their guns to bear on the beam. If this were efficiently done, there would not be so much necessity for this complicated method of anchoring; but this method or some similar one would be necessary in an open roadstead, or in a large harbour with several entrances.

Diagram IX represents a fleet of six ships, surrounded by the beams of four electric lights, which are burnt in four gunboats, the ships being protected as before described, the dotted lines showing the wire hawsers between the ships. If the wind changes the wire hawsers would have to be eased, or perhaps let go and dipped, if the ships turn right round. We have placed the ships at a cable apart and the lines at $1\frac{1}{2}$ cables apart, but if it would be considered safe, would like them even closer.

Diagram X represents a fleet of sixteen ships, anchored in a similar formation to the preceding diagram.

If there were transports, they could be anchored in the centre. Those gunboats burning the lights would be required if there were more ships, and they would have to be placed half way along the sides as at A; but experiments are very much wanted to find out the length of beam that could be used for a defence similar to the above. We should think 2,000 yards is perhaps as long as can efficiently be used.

In either of these cases a boat to fire a Whitehead torpedo would have to pass through the beam of light, and if the guns were laid

just inside the beam, they ought to be hit before having time to fire a Whitehead; and in view of the latest improvement in using an outrigger torpedo against ships defended with nets, any outrigger boat ought to be rendered *hors de combat* before getting near the ship's nets. If the nets are properly placed round the ships, even if a Whitehead torpedo be fired, it will not seriously hurt a ship, and in fact ought only to shake the ship if the net fires the torpedo. It is very necessary that the nets should be well laced together, as if the lacings are only carelessly passed, there are a great many chances in favour of the Whitehead.

The Navy is besides supposed to defend all harbours which the Royal Engineers do not defend; they, as we mentioned before, defend our military ports, coaling stations, and a few of our principal commercial ports, or we might be called to defend any newly acquired harbour, such as Port Hamilton, which was defended by the China squadron during the Russian scare.

A defence similar to the above can always be arranged, and has been practically tried several times at Bantry Bay, and laid very quickly indeed, the principal part of the defence being laid in thirty-six hours from the time of the fleet anchoring.

The Attack of Harbours.

We next come to the second part of this chapter, viz., "the attack of harbours."

This we all hope and expect will be the principal part of our work in any future war, and that having defended our harbours as a precaution against any emergencies, we shall be principally engaged in attacking the enemy's harbours.

There are certain fundamental rules we are bound to observe when planning the attacking of an enemy's harbour, which the introduction of submarine mines has made necessary. Thus, during the American civil war, wooden ships were able to run past batteries that were armed with very heavy guns, but directly submarine mines were placed across the channel and under the fire of the guns of the forts, this was very considerably modified, as before the wooden ships could advance, they had first to clear the channel, which occupied a certain time, during which they were under the fire of the fort, and thus rendered their passage very often impossible, and always with some considerable loss.

Most of the advantages gained by the Federals were gained before the Confederates used mines.

The first rule is that if the place is known to be defended with mines—

A systematic attack on their mine field must be made, so as to clear a passage broad enough for the ships to move up and bombard the forts.

Secondly. That the ships must be powerful and numerous enough, when there, to be able to silence the guns of the fort.

Thirdly. The ships should be protected with torpedo nets, and

might have a torpedo dredge fixed ahead, projecting sufficiently far to prevent the ship being hurt by any mine it fires.

Fourthly. When the attack once begins, it should be carried on without intermission until the channel is cleared and the forts are silenced, and great care should be taken to prevent the enemy dropping mechanical mines in that part of the channel which has been cleared.

There are four different operations which would probably have to be done in order to clear a long channel, viz.: 1, Sweeping; 2, Slow creeping; 3, Rapid creeping; 4, Countermining.

But before commencing an attack it is advisable to study the chart well, and procure spies if possible, to find out where to expect to find the enemy's mines.

If the water gets deep very quickly, it may safely be assumed that there are no mines very far from the shore, and as the forts will most probably be situated at the entrance of the harbour, electrical mines will only be used, so sweeping will not be required.

If the water gets deep very gradually, the mines may extend some distance to seaward, and as electrical mines are not laid outside the range of guns, mechanical mines will only be found some distance from the shore, therefore sweeping will first have to be done.

The fleet should anchor some distance from the shore, outside where the mines are supposed to be laid, and get their nets out.

Prepare their pulling boats for sweeping.

Mark the channel to be cleared with small buoys, send the boats in by pairs, to sweep a certain length of the channel and go over the same ground in opposite directions, and when they are thoroughly satisfied that it is clear of all mines, the boats to thoroughly sweep another length of the channel, until it is supposed they may have reached the neighbourhood of the electrical mines, when the process of slow creeping will begin. This, as well as sweeping, should be done at night, except when the sweeping is carried out well out of range of the enemy's guns, but in either case the sweeping boats should be supported by some armed steamboats, which should keep in rear until wanted.

Sweeping should not be carried out at low water if possible.

The idea of slow creeping is to pick up the enemy's cables, having first of all broken the continuity of the core, and underrun the cable to see if it leads to a multiple cable, and if it does, to cut the multiple cable, thus rendering all the mines attached to it useless.

This can only be carried out when not under fire, or when the enemy more or less permits it, so that probably slow creeping will not be able to be carried out, and instead, rapid creeping will have to be done. The great thing is to have plenty of boats fitted to carry the creeps, and steamboats to tow them; when all is ready, move the ships up (if not previously done), engage the forts, and under cover of the guns send the creeping boats away to creep the remaining part of the channel, the boats to work in opposite directions, so as to avoid the dummy cables; if possible, send some boats in along the shore where the firing stations are supposed to be.

When this part of the channel has been well crept over, the countermine launches should be ready to lay the countermines. And then again, under cover of the fire of the fleet or at night, first assuming that the fleet are getting the best of the forts and will be able to move up and occupy the channel cleared, run the first two lines of countermines; when run, fire them immediately, and in half an hour's time the fleet should move up and occupy the channel cleared; then other two lines should be run, and so on, until the channel is cleared. If a broader channel be required, creeping boats can go on creeping on the sides of the main channel cleared. If there is a boom across the entrance, it would be first of all advisable to run a line of countermines over it, and then it can be best discharged by sending one of the ships to ram it, which is certain to destroy any boom that can be made.

We have now roughly described how to destroy the submarine mines which may be laid by the enemy; these being destroyed, the bombardment of the forts is very much the same as it was some years ago, except being easier since the introduction of steam. If it be intended to occupy the forts, &c., soldiers will most probably be required to help the landing party from the fleet.

We have not yet mentioned how to move the ships up to engage the forts.

After the sweeping boats have cleared part of the channel, one of the ships might move up and anchor at the end of the cleared part of the channel, and if it is within range of a fort the ship should have good bow fire; then, as more of the channel is cleared, the ships can move up one by one, each one anchoring in front of the last anchored, and after the creeping and countermining has cleared more of the channel, the last ships move up first and occupy the place, anchoring before the first ships, and so on; this saves the necessity of all the fleet weighing each time and moving up.

With a fleet in line ahead like this, as it approaches the forts it brings a very large amount of guns to bear.

If any of the defender's torpedo-boats attack the ships in this position, the ships must trust to their nets, Nordenfelt guns, and should have their own torpedo-boats handy to help to protect them, the cleared part of the channel being so narrow as to prevent them manœuvring to defend themselves.

We have given a brief idea how to destroy the enemy's mine field, which before any future bombardment of the forts belonging to any civilized Power, we shall undoubtedly have to do.

With an enemy always on the alert, and with a good proportion of torpedo-boats, &c., it will be very hazardous work, and will take some time probably to do, without it is considered desirable to run a little risk; but imagine a torpedo exploding under one of our ironclads' bottom, what a great block it will make in the channel! and it seems that a fleet engaging in an attack of this kind should be provided with some appliances for raising the ships that are sunk by mines or torpedoes. Some Officers propose ships should be already slung with chains in case of an accident of this kind, and that the necessary

lighters, &c., should be attached to a fleet as well as a floating dock; this of course will vary very much with the place attacked. The ships would require an extra supply of ammunition before a bombardment, and care should be taken that if the enemy's guns are mounted behind earthworks, there should be plenty of common shell on board the ships.

Having thus discussed the different changes in naval warfare caused by the introduction of the ram, the torpedo, and the submarine mine, we should like, before finishing the essay, to briefly sum up the different points which seem to require more attention.

They are as follows:—

1st. An increase in the age of entry of naval cadets, and a more mathematical and scientific education for the executive branch, without neglecting practical seamanship; thus if more Officers be highly trained, naval Officers will be better able to express an opinion about the construction of our ships and ordnance, which it seems very important they should be able to do.

2nd. The Channel and Reserve Squadrons might meet every year, and practice at mimic warfare on similar lines to that carried out annually by the Russian fleet, where one part of the fleet declares war against the other part for about ten days or a fortnight, and during which time they attack each other in every conceivable way, to represent as near as possible what would happen in actual warfare; if this were carried out every year, even more experience would be gained than during the annual torpedo operations at Bantry Bay.

3rd. Experiments might be carried out to prove whether a ship's bow wave will actually deflect a Whitehead torpedo, as was supposed to be the case with one of the torpedoes fired at the "Polyphemus."

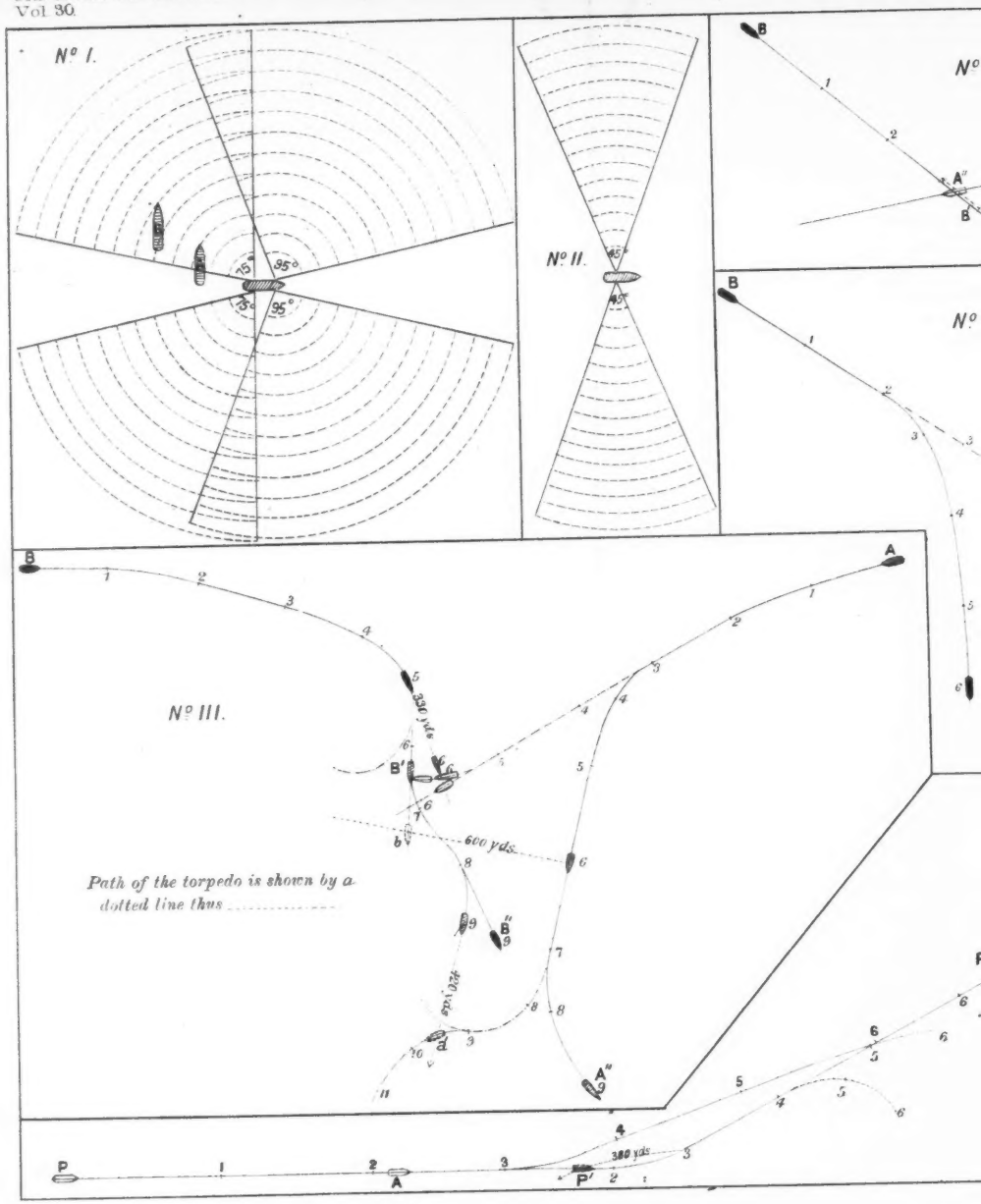
4th. It seems very important that experiments should be carried out to find out the best way to anchor a fleet so as to resist a torpedo-boat attack, and also the best method of using the electric search light for the defence of the fleet.

5th. It would also seem advisable that experiments on a larger scale should be carried out with electrically propelled boats, as these boats are particularly suitable for torpedo-boats, on account of their being noiseless, and showing no sparks, &c., and thus would be very difficult to discover.

6th. The defence of our commercial ports by torpedo- and gun-boats, and also the formation of local corps of Naval Torpedo Volunteers for these ports, seem to require immediate consideration.

These appear to be the most important points which press for consideration, although every day some new improvement is being brought out, and we must always be on the watch as to its practical utility for the Service, or whether it will not modify the present conditions of naval warfare. Thus at present the Nordenfelt submarine boat occupies the attention of the European navies, which, if it prove a success, will prove a very cheap and effective method of defending our harbours.

In conclusion, we must apologize if we have stated any views in opposition to those of more experienced Officers.


No I.
75°
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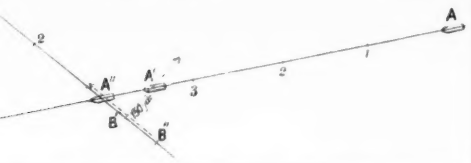
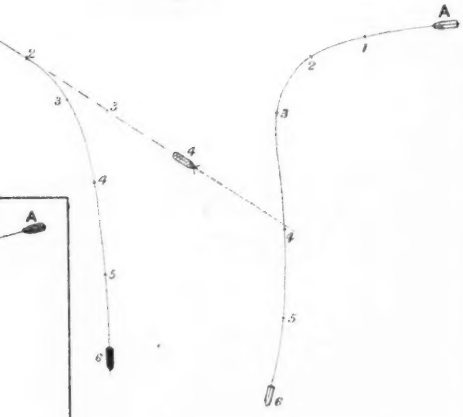
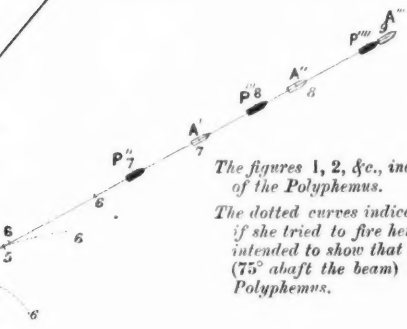
N° IV. Fig. 1.



N° IV. Fig 2.

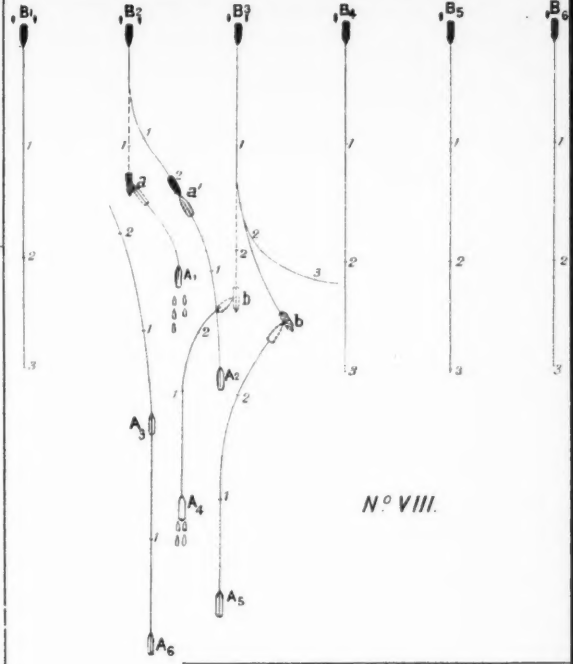




N° V.

The figures 1, 2, *&c., indicate the different positions of the Polyphemus.*

The dotted curves indicate the curves A *would take if she tried to fire her other torpedo, and they are intended to show that she cannot get the hearing on* (75° *abaft the beam*) *so as to be able to hit the Polyphemus.*



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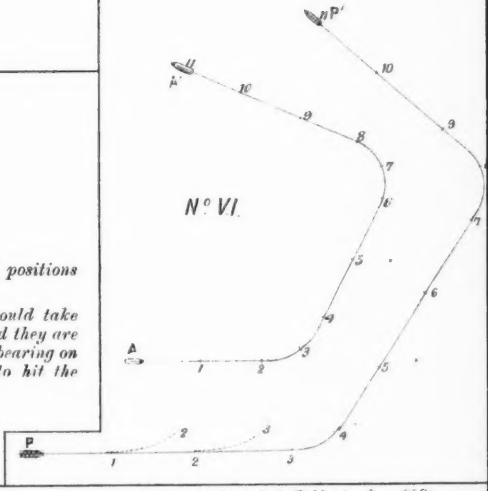
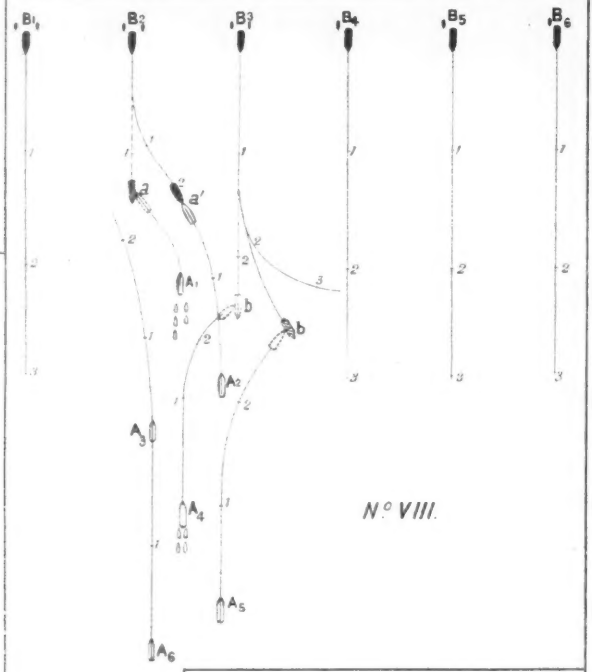


N° VI.

Harrison & Sons, 14th St. Martins Lane W.C.



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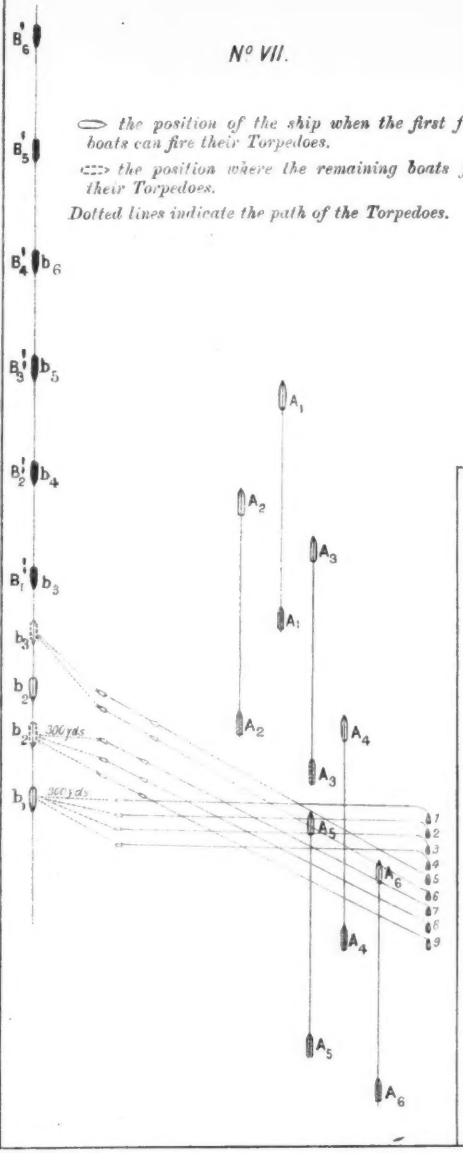
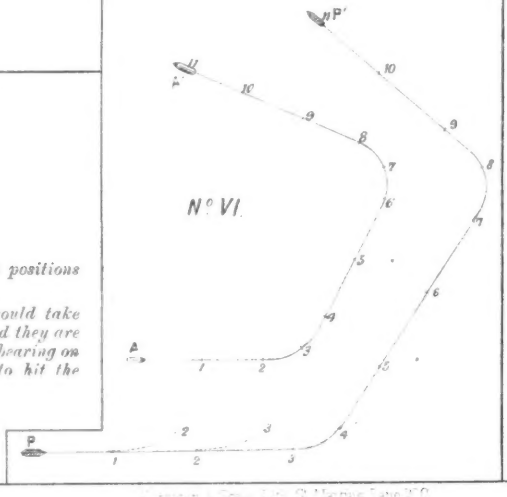


N° VII.

⬭ *the position of the ship when the first four boats can fire their Torpedoes.*

⬭ *the position where the remaining boats fire their Torpedoes.*

Dotted lines indicate the path of the Torpedoes.



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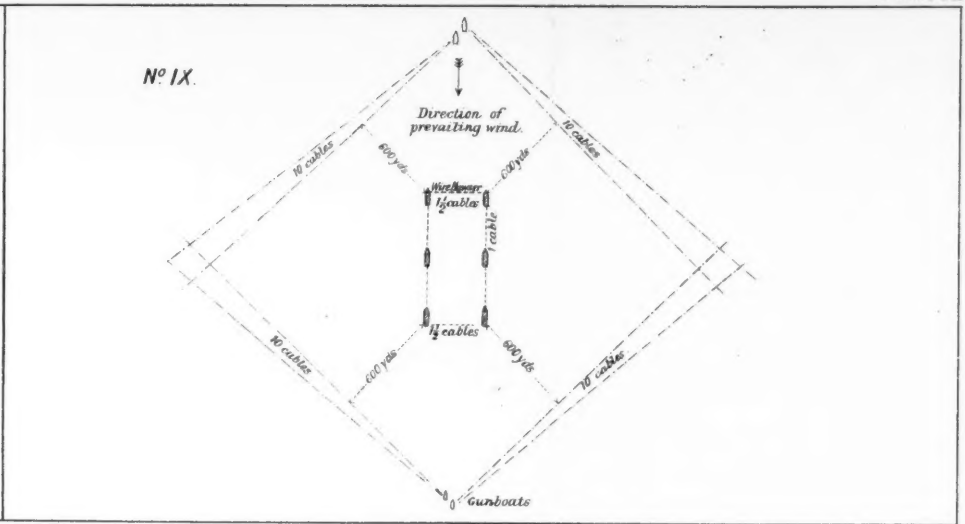

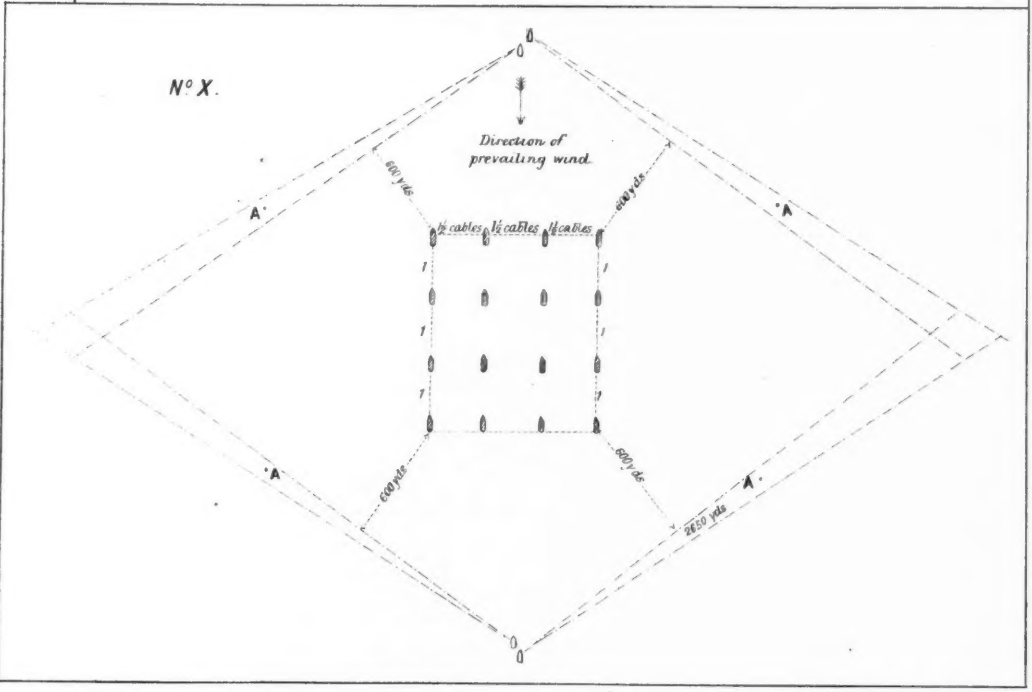

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ESSAY.[1]

THE CHANGES IN THE CONDITIONS OF NAVAL WARFARE, OWING TO THE INTRODUCTION OF THE RAM, THE TORPEDO, AND THE SUBMARINE MINE, HAVING REGARD CHIEFLY TO THE FOLLOWING POINTS IN OUR OWN AND FOREIGN NAVIES, VIZ.:—TRAINING OF PERSONNEL; CONSTRUCTION AND PROTECTION OF MATÉRIEL; AND ATTACK AND DEFENCE OF SHIPS AND HARBOURS.

By Captain Robert Hastings Harris, R.N.

"England expects every man to do his duty."

Chapter I.—*The Changed Conditions of Naval Warfare.*

The subject for an essay as quoted above the text of our present chapter is a large one. What volumes have been both written and spoken, and what controversies have been excited concerning the three separate points to which our attention is more prominently directed, and rightly so, for it is not alone recognized by many in England, but it has been publicly proclaimed by several foreign naval experts, some of whom are entitled to command our greatest respect for the eloquent and vigorous expressions of opinion that they have given us,[2] if not for the refreshing candour with which they do not hesitate to say that if a nation like ourselves should be unwise enough to ignore the study or neglect the use of those novel weapons which threaten to change and revolutionize the whole system of naval warfare, such a nation must on some future day pay the penalty for her negligence by suffering a serious naval reverse, probably leading to a total collapse of her maritime power.

Coincidently with the rapid improvement in weapons of destruction, the art of naval war, like the art of military war, is perpetually changing, rapidly, in fact, resolving itself into a new strategy suited to the weapons of its day. It is idle to deny that the nation which has best adapted herself to the changed conditions of her day will be

[1] The length of the essay so far exceeded the limits prescribed by the regulations that it could not be admitted to competition for the medal.

The essays by Commander Kingscote and Captain Dowding, R.N., received honourable mention.—Ed.

[2] *Vide* the French Admiral Aube's "Treatise on Naval Warfare and the Military Ports of France," and others, &c.

most generally victorious in battle. In no epoch of the earth's history has the art of naval war been more radically and distinctly changed than during the past quarter of a century.

It is thus fearfully incumbent on us in Great Britain to see that after due trial we unhesitatingly accept and adapt ourselves to each changed condition, for at no other period has any nation presented a more tempting object to the ambition and cupidity of rival nations than we do at this moment. Our unarmed ships are daily and peacefully traversing the vast seas and oceans of the globe, deeply laden with rich treasure and costly merchandize; our wealthy and populous outlying towns and Colonies are scattered and numerous, and they are mostly unarmed and helpless.

What has protected these in peace and prosperity for the last seventy years? Nothing but our command of the seas and our grand naval *prestige*.

These blessings were obtained by the wisdom, valour, and hardihood of our forefathers, but the battles by which they won them were fought under vastly different conditions from those we shall have to fight to retain them, and they will not much longer be suffered to pass unchallenged. Abundant proof exists that in the naval wars of ancient days the invention of a new weapon or the adoption of an improved system of naval tactics, usually succeeded in transferring the naval supremacy of the day to those who were clever and bold enough to first adventure their practicability.

To us personally it is self-evident that chronic neglect or supineness in regard to naval matters must some day most certainly put it within the power of some other nation to crush the maritime supremacy of Great Britain as surely as Carthage, with all her wealth, was beaten and subdued by the superior vigour of ancient Rome.

We say again, and it cannot be said too often, if the war navy of Great Britain be neglected, and a long-established and parsimonious economy be allowed to impair the fighting efficiency of her war ships, and discourage the well-proved energy and self-reliance of her naval Officers and seamen, then indeed will there be no need for some hostile foreign statesman to make the words of Cato, as he declaimed in the Roman Senate, "*Delenda est Carthago*," applicable to Great Britain, for simultaneously with the fall of her naval supremacy must our glorious and beloved country inevitably cease to be one of the Great Powers of the world. Then will England cease to be the England of our illustrious ancestors; then she must dwindle, possibly step by step and by slow degrees, but nevertheless with absolute certainty, to the same level as Holland, Portugal, or Denmark.

Do not let us ever fall into the error of supposing that our present maritime supremacy is a heaven-born gift, always to be retained by virtue of our insular position, or on account of that grand and not to be undervalued naval *prestige* which has been bequeathed to us by the valour of our forefathers, or because of our great and peculiar naval resources. No; did not the Phœnicians, the Romans, the Greeks of old, and many other nations of later years successively assume, and perhaps at the time with good reason, that they were

for ever to be unrivalled on the seas? vainly believing their maritime supremacy to be permanent. But was it so?

Let us Englishmen endeavour to be wiser in our generation, and profit by the lesson that they teach us, one and all striving to prevent our hitherto almost unquestioned naval superiority from slipping away from us. If we do let it go, shall we ever regain it?

But it may be said, need we have any uneasiness on this score? for surely more interest is taken in naval affairs now than of yore. Look at the daily papers; see the patriotic efforts of some of them; notice how continually Admiral So-and-so writes concerning the necessity of keeping up our naval strength. Most true indeed. But where is the result? Does the great interest in the welfare of their country exhibited by these few patriots permeate the whole nation and lead to effective results? No; it may be truthfully answered that the large majority of Englishmen are in a state of profound ignorance as to the efficiency or inefficiency of their naval resources, and more profoundly ignorant as to the naval resources of other maritime nations. Most true it is, however, that when, as is spasmodically the case, the needs and shortcomings of the Navy are properly brought home to the minds of our voters and their representatives by some scare, or by the near prospect of war, then few will grudge or flinch from spending any money to place their Navy on a proper footing; but, alas! it is equally true that the scare will subside almost as quickly as it arose, and then once more the all-important question that can be well expressed in very few words, viz., the entire safety and welfare of the nation, is again for a time dismissed from the public mind, which will shortly afterwards be for months attentively engrossed with the more burning question of an extension of the franchise, the disestablishment of a Church, a local management Bill, or the relative merits of the Ministry and Opposition.

There is nothing new in all this; it is only history repeating itself again and again; but whereas half a century ago, when all things moved far more slowly than they now do, this summary dismissal of naval questions might have wrought comparatively little harm, and did not, as it now does, jeopardize the very existence of our country. Then our sea-girt isles were almost self-supporting, our population was one-third less than it is now;[1] then our importation of foreign food was practically nil, last year the value imported was 122,824,848*l.*, averaging about 3*l.* 9*s.* per individual, while the totals of our imports and exports reached the enormous yearly sum of 732,228,000*l.*, a large proportion of which is always on the high seas and consequently assailable. What a temptation this must be to our neighbours. Why, the wealth of the Spanish galleons we used to capture and pillage represents in comparison an infinitesimal sum!

In those days we were acknowledged incontestably superior on the high seas; then our unrivalled seamanship was a national safeguard; then our ships were self-containing in all the elements of their efficiency; the steam-engine was in its infancy, the ram was unheard

[1] Population in 1831 was 24,932,485; 1881 was 35,241,482.

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These blessings were obtained by the wisdom, valour, and hardihood of our forefathers, but the battles by which they won them were fought under vastly different conditions from those we shall have to fight to retain them, and they will not much longer be suffered to pass unchallenged. Abundant proof exists that in the naval wars of ancient days the invention of a new weapon or the adoption of an improved system of naval tactics, usually succeeded in transferring the naval supremacy of the day to those who were clever and bold enough to first adventure their practicability.

To us personally it is self-evident that chronic neglect or supineness in regard to naval matters must some day most certainly put it within the power of some other nation to crush the maritime supremacy of Great Britain as surely as Carthage, with all her wealth, was beaten and subdued by the superior vigour of ancient Rome.

We say again, and it cannot be said too often, if the war navy of Great Britain be neglected, and a long-established and parsimonious economy be allowed to impair the fighting efficiency of her war ships, and discourage the well-proved energy and self-reliance of her naval Officers and seamen, then indeed will there be no need for some hostile foreign statesman to make the words of Cato, as he declaimed in the Roman Senate, "*Delenda est Carthago*," applicable to Great Britain, for simultaneously with the fall of her naval supremacy must our glorious and beloved country inevitably cease to be one of the Great Powers of the world. Then will England cease to be the England of our illustrious ancestors; then she must dwindle, possibly step by step and by slow degrees, but nevertheless with absolute certainty, to the same level as Holland, Portugal, or Denmark.

Do not let us ever fall into the error of supposing that our present maritime supremacy is a heaven-born gift, always to be retained by virtue of our insular position, or on account of that grand and not to be undervalued naval *prestige* which has been bequeathed to us by the valour of our forefathers, or because of our great and peculiar naval resources. No; did not the Phœnicians, the Romans, the Greeks of old, and many other nations of later years successively assume, and perhaps at the time with good reason, that they were

for ever to be unrivalled on the seas? vainly believing their maritime supremacy to be permanent. But was it so?

Let us Englishmen endeavour to be wiser in our generation, and profit by the lesson that they teach us, one and all striving to prevent our hitherto almost unquestioned naval superiority from slipping away from us. If we do let it go, shall we ever regain it?

But it may be said, need we have any uneasiness on this score? for surely more interest is taken in naval affairs now than of yore. Look at the daily papers; see the patriotic efforts of some of them; notice how continually Admiral So-and-so writes concerning the necessity of keeping up our naval strength. Most true indeed. But where is the result? Does the great interest in the welfare of their country exhibited by these few patriots permeate the whole nation and lead to effective results? No; it may be truthfully answered that the large majority of Englishmen are in a state of profound ignorance as to the efficiency or inefficiency of their naval resources, and more profoundly ignorant as to the naval resources of other maritime nations. Most true it is, however, that when, as is spasmodically the case, the needs and shortcomings of the Navy are properly brought home to the minds of our voters and their representatives by some scare, or by the near prospect of war, then few will grudge or flinch from spending any money to place their Navy on a proper footing; but, alas! it is equally true that the scare will subside almost as quickly as it arose, and then once more the all-important question that can be well expressed in very few words, viz., the entire safety and welfare of the nation, is again for a time dismissed from the public mind, which will shortly afterwards be for months attentively engrossed with the more burning question of an extension of the franchise, the disestablishment of a Church, a local management Bill, or the relative merits of the Ministry and Opposition.

There is nothing new in all this; it is only history repeating itself again and again; but whereas half a century ago, when all things moved far more slowly than they now do, this summary dismissal of naval questions might have wrought comparatively little harm, and did not, as it now does, jeopardize the very existence of our country. Then our sea-girt isles were almost self-supporting, our population was one-third less than it is now;[1] then our importation of foreign food was practically nil, last year the value imported was 122,824,848*l.*, averaging about 3*l.* 9*s.* per individual, while the totals of our imports and exports reached the enormous yearly sum of 732,228,000*l.*, a large proportion of which is always on the high seas and consequently assailable. What a temptation this must be to our neighbours. Why, the wealth of the Spanish galleons we used to capture and pillage represents in comparison an infinitesimal sum!

In those days we were acknowledged incontestably superior on the high seas; then our unrivalled seamanship was a national safeguard; then our ships were self-containing in all the elements of their efficiency; the steam-engine was in its infancy, the ram was unheard

[1] Population in 1831 was 24,932,485; 1881 was 35,241,482.

of except as a remnant of barbarism, torpedoes or submarine mines were almost unknown, while the naval gunnery of the day was absolutely charming from its very simplicity. What dreamer would then be adventurous enough to say that the fleets of the future would manœuvre at 12 or 14 knots speed, and that they would have entirely discarded the use of sails in action? Had he done so he would have been pronounced well fitted for an asylum. Even quite recently few men were bold enough to think that steam was capable of being used afloat except as an inferior auxiliary to sail power.

In those good old days of our naval pre-eminence there was no need to reckon and compare ship against ship as in these days of modern armourclads; there was then no need to inquire whether the speed of any ship was 11, 16, or even 18 knots; there was no question as to the relative merits of steel, compound, or iron armour; there was no vexed and hotly disputed question as to how this armour was to be distributed. There could be no quarrel as to the merits of revolving turrets or barbette towers; no protection from quick-firing and machine-guns was imperatively demanded. True it is that naval architects were not of one mind as to the form of hull and amount of beam to be given, but no such difficulties as those we have so hastily mentioned had fallen around them.

Go back to those bygone days and name at haphazard any English line-of-battle ship, and she floated, if well found, the unquestioned equal or superior of any foreign vessel; her speed at the most differed only a knot from any possible opponent. Placed on the high seas she feared nothing. She felt no sense of insecurity from the possible approach of a tiny torpedo-boat capable of terminating her existence in a few seconds; she dreaded no ram with a speed far exceeding her own; in fact, barring a heavy gale and a lee shore, or an overwhelming assault from several of her hostile compeers, there was nothing that could detract from the proud self-confidence she was so well justified in assuming.

From the day that steam came to the front, almost simultaneously as it was with the improvements in shell fire, all this was changed. In a few years the transformation from wooden to armour-plated battle ships was completed, and now we have year by year, nay, almost day by day, more fresh and startling innovations in the instruments of naval warfare than were witnessed by two generations of our forebears.

Steam is omnipotent; a wooden ship will soon be a thing of the past; the armoured ship of twenty years back, then never to be surpassed, has become well-nigh obsolete; and with all this we err not when we predict that the immediate future will see far greater and still more astonishing changes than any of those which we have so summarily discussed.

Was there ever before a period in the history of the world when men's brains were so active or their minds so enterprising in the matter of warlike inventions as they now are? More especially is this so in regard to the attack and defence of ships. Surely, then, this is no time for a nation depending entirely on maritime supre-

macy to provide daily food for her people, to pause and take breath over her naval construction, more especially when she contemplates other nations who have few Colonies, and, comparatively speaking, little interest on the high seas, and who, though well-nigh overwhelmed by their military burdens, are yet the most active in naval matters, failing not to seize with both eagerness and aptitude on any new engine of naval destruction, or on some novel design for a war vessel, secretly hoping that by so doing they may threaten the might, or perchance become heirs to the wealth of some greater maritime Power.

If the foregoing be correct, and we ourselves conscientiously believe it to be so—indeed we should be more than happy if it could be openly controverted—then we must pause not in Great Britain to amply sustain the efficiency of our war Navy: and we must do more: we must jealously watch everything that is likely to imperil the great and glorious legacy that has descended to us; we must closely examine and try all newly invented methods of war; if on close examination and experiment we find that any of them contain aught that may endanger our heritage of the sea, we should not hesitate at any cost to assure ourselves of possessing their mastery.

In taking account of the great cost of our Navy, let us always carefully weigh against it the loss that would be entailed upon our country by even a temporary check to our naval power; let us again note the fact of our imports and exports of 1883 having reached the enormous sum of nearly 733,000,000*l.*, while the sum now spent in maintaining the Navy is less in proportion to this tremendous mercantile transaction than in any former year.

Before quitting this part of the subject, let us endeavour to grasp, if only in a small way, the misery and starvation that would be inflicted on our fellow countrymen, women, and children, by even a momentary cessation of this stupendous trade. The supplies of export material would rapidly increase, with no prospect of finding a foreign market; there would be a seriously diminished supply of goods from abroad to fill the home market, which would be glutted with our own manufactured goods.

We feel that we have said enough. The necessity for making any apology for being over diffuse or too argumentative in this or in our following chapters is already precluded. Too deeply do we feel the expediency of any matter that concerns our naval supremacy being relentlessly threshed out and continually kept in view, to dread either criticism or ridicule.

We will conclude our first chapter by drawing attention to the two tabulated forms which we annex, and which are illustrative of the comparative displacement tonnage, armament, cost, and complements of the most prominent war vessels of 1805 and of the present year. It is almost absurd to contrast the difference between the vessels of these two periods, not only on account of their singular diversity of type and construction, but for the ridiculous augmentation of the cost of the later vessels. If then we find that the 1st class ship of the present day to attain perfection must cost 800,000*l.*, or nearly eight

1805.

Class of vessel.	Tonnage displacement (about).	Armament (about).	Cost (about).	Crew (about).	Capabilities, &c.
1st class, three-decked line-of-battle ship.	3,500	110 guns	£ 110,000	1,000	Equal to any vessel; superior to all smaller vessels; average speed.
1st class, two-decked line-of-battle ship	3,000	90 „	90,000	800	Equal to engage any vessel; superior to all smaller vessels; average speed.
Frigate, larger type	2,000	50 „	50,000	450	Equal to all vessels not line-of-battle ships; superior to all else; faster than most vessels.
Corvette, „	1,000	20 „	20,000	200	
Sloop	500	18 „	13,000	120	Inferior to the above named; superior to all others; average speed.
Brig..............................	350	10 „	10,000	100	„ „ „
Schooner	200	8 „	5,000	50	„ „ „
Cutter	100	6 „	2,000	25	„ „ „

Class of vessel.	Tonnage displacement (about).	Armament (about).	Cost (about).	Crew (about).	Capabilities, &c.
			£		
1st class, armour-protected vessel, "Italia" type.	13,500	4 very heavy, 8 smaller, and machine-guns	800,000 to 1,000,000	450	Equal to any vessel as far as gun power goes, but liable to be destroyed by swift rams or torpedo-boats; high speed.
1st class, armour-protected vessel, "Collingwood" type.	9,150	4 heavy, 6 smaller, and machine-guns	600,000 to 700,000	400	Equal to most vessels in gun power, but liable to be destroyed by swift rams or torpedo-boats.
2nd class, armoured vessel, "Audacious" type.	6,000	10 guns and machine-guns	400,000	450	Speed only moderate, armour thin; inferior to modern armour-clads, &c.; liable to be destroyed, &c.
2nd class, armoured vessel, "Impérieuse" type.	7,390	4 heavy, 6 smaller, machine-guns	450,000	400	Equal to most vessels; superior to many; speed fast; liable, &c.
Frigate, "Inconstant" type	5,780	16 guns	400,000	450	
	Almost obsolete, there are only three in our Navy.				
Corvette, "Calliope" type	2,770	16 guns	200,000	300	Equal to an engagement with any unarmoured vessel; unequal to engage armoured vessels; speed good; liable to be destroyed by ram and torpedo-boats.
Sloops	1,000	6 to 10 guns	70,000	150	Armament good; speed inferior; liable to be destroyed by ram and torpedo-boats.
Gun-vessels	700	6 to 8 guns	40,000	100	" " "
Gunboats	450	4 guns	35,000	80	" " "
Torpedo cruizers	1,430	4 light and 5 machine-guns	—	—	Speed very good; able to destroy both armour-clads and other vessels with torpedoes, also to destroy torpedo-boats with gun fire.
Torpedo-boats	Various sized and priced boats of very high speed, but fragile construction, able to destroy armoured or any vessel with torpedoes.				

times the value of her predecessor of only eighty years ago, what do we suppose the vessel of twenty years' time will cost? We may be sure, even if we had no other ideas on the subject, that this pace cannot last.

Possibly the modern war ship can do eight times as much as the vessel of older type could hope to do, and from the fact of her existence being more in accord with her time, she is undoubtedly of infinitely more value to the State; but neither she nor any of her smaller compeers by any means enjoy the same immunity from the risks of destruction as did their predecessors in the earlier part of this century; for as we have already said and shall frequently repeat, our new ships have to face and fear many and serious attacks that may be easily fatal to their existence, and which attacks will entirely ignore their reputed above-water invulnerability.

And why? Because men's intellects are gradually rebelling against those impossibilities, for whose perfect attainment they have for years been earnestly striving in the as yet never-ended battle between the guns and the plates, and also because they have in part recognized the power that is gained by attacking the armoured monsters of their own creation, with lighter and swifter vessels. Consequently on this recognition and by the exercise of an unbounded ingenuity, they have contrived small vessels that can in smooth water outpace the largest armour-clad, and have armed them with a weapon which places the smaller vessels under certain circumstances on a more than equal footing with the greater.

If this has been done with small and light vessels, what new and surprising developments of power and speed may we not expect in the almost immediate future, when the same successes that the smaller vessels have achieved are attempted with vessels of from 500 to 700 tons displacement? We cannot ourselves see any reason why a smooth water speed of from 25 to 30 knots could not be attained in such vessels, that is, if all else be sacrificed to speed; two or three machine-guns and some twenty Whitehead torpedoes to be the limit of their armament; the latter should be ejected from positions on the bows, beams, and quarters, as well as right ahead and right astern.

Vessels of the above type should be more than a terror to those monster armoured vessels that both we and other nations fancy we are obliged to create. Such vessels would be too swift in themselves to dread either the ram, the torpedoes, or the torpedo-boats of the huge vessels they would attack; and whose guns they would half muzzle by choosing the hours of darkness, fog, rain, or mist for their opportunity.

If the above presumptions be tenable, then high speed must be the ruling factor of modern naval wars.

The stubborn combat of ships broadside to broadside will be a thing of the past, its place will be usurped by the fight of swift vessels, manœuvred by the skill, activity, and strategy of a highly-trained personnel.

Thus may come the solution of that problem of which we are so tired, "guns *v.* plates;" but it has not yet come to this, and in our

ensuing chapters, we shall strive to deal not so much with the problematical as with the real, and confine ourselves to writing as we are required to do, on "the changed conditions of naval warfare" as we now know them.

CHAPTER II.—*The Ram.*

Closely following the improvements in shell-fire, and more closely following the absolute victory of steam over sails as the propelling power of ships, and upon which we have already commented, came the introduction of the ram as a leading naval weapon. There was no need to wait for a naval battle to enforce attention to its extreme power; the almost daily collisions of our merchant steamers were themselves living witnesses of its potency.

There was no need to resort to ancient history, therein to study the famous tactics of the Romans, as with their well-manned and rapidly-propelled galleys they sought by means of the ram or beak to rend and sink their foes. Beaten eventually in the past by the improved methods of shipbuilding, and the more skilful use of sails, the ram vanished for centuries, but at the bidding of steam skilfully applied, and used to drive ships rapidly in every direction, it has in the present reappeared, not only quite as formidable as of yore, but with greatly increased powers.

What can equal the destructive force of a ram propelled at 12 knots or possibly at a higher speed, bearing on its point the whole weight of a 10,000-ton ship?

What a weapon! The blow when dealt does not waste energy above water, it probably will avoid armour-plating; it is not liable to ignominious failure like a locomotive torpedo by reason of non-explosion; no explosion is necessary. Deliver its blow ably and with seamanlike vigour, and it will crush, rip, or rend the very vitals of a stricken vessel.

But with all this said or done, the blow of a ram is not mechanical. Whether it shall be effectively used or not, depends on many circumstances or causes: we will name some of them.

The successful use of the ram in a naval action must, in the first instance, hinge on the nerves of steel and the keen and well-trained judgment of the seaman who guides and controls the ship that bears it; constant practice in manœuvring his ship at all speeds must have made him thoroughly the master of her every movement. She should respond to his will as quickly as the well-trained horse obeys the least touch of the rider who is familiar with him. In the second place, the successful use of the ram must depend on the comparative speed and turning power of every ship; high speed and rapid turning power make any ship an efficient ram.

In an engagement between two hostile vessels having anything like an equality of speed and turning power, we think it improbable that there will be any ramming.

Given, however, higher speed and equal turning power, and the option of ramming should rest with the fastest ship.

Given higher speed and less turning power, all attempts to ram the handier ship will be futile, presupposing, however, in all these cases, that the two engaging vessels do not deliberately seek a stem to stem encounter. If they do, then arises the question, will it be fatal to one or both of these determined foes? We venture to say that it may not be fatal to either, apart from the extreme difficulty of two vessels hitting each other end-on; and if two ships, rapidly approaching each other stem to stem, are able even to keep a steadfast course, still then, not once in a score of attempts will point of ram meet point of ram; no, we say that even if they strike each other, the bows will often glance and deflect. The two vessels it is true may meet with a fearful crash, and then with a terrible dismantling of outside hamper rush rapidly past each other, only to swiftly wheel and renew the charge. But let one adversary through a weaker courage, perhaps merely through an error in judgment, fail to oppose her stem to the stem of her foeman, and thus expose by a yard the broad of her bow to the ram of the enemy, swerving either to starboard or to port, it matters not which, then if eye be keen and judgment good, the point of her adversary's spur will be swift to penetrate the flimsy bottom plating opposed to it, and the velocity of the stricken ship will materially assist in effecting her own rapid disablement or destruction; witness the "Vanguard" and "Grosser Kurfurst" disasters.

When two ships have rapidly passed each other perhaps structurally uninjured, or may be without colliding, then will come the opportunity to test the skill of the Captain of either vessel; then will be shown whether one or both understand thoroughly the manœuvring powers of their ships. The Captain who is well trained, and who has by frequent practice instinctively become the master of his vessel's every movement, will decide at a glance and by force of intuition, whether he will wheel to starboard or to port; he will know at what speed his ship will best make a rapid semicircle; he will have no doubt as to whether he shall reverse or stop either of his engines; he will be saved from making any error that might be fatal to himself; and he will from his well-trained promptness be ready to take every advantage of a false move on the part of his enemy.

With all this written and undeniable, we do not allow that the full power of the ram can be generally developed in a single-ship action; on the contrary, we say that in proportion to the number of ships engaged in a sea battle, so will the power of the ram increase. Smoke, confusion, disablement of engines, steering gear damaged, error in the manœuvres of a fleet, all or any of these circumstances will make a favourable opportunity for the use of the ram. Of this we have a notable example in the action off Lissa, while in the few single-ship actions that have occurred since the ram has been modernized as a naval weapon, all attempts to use it with vessels each under command have been at the best futile or abortive.

In exact contradiction, however, to the action off Lissa, and to the lesson taught us by the gallant Tegetoff, we hold that the ram ought to be the weapon of the fleet which is numerically the strongest; all

other things being equal, it seems almost self-evident that a force superior to another in numbers, say to the extent of three to two, must have a decided advantage so far as ramming is concerned; with gun-power alone the advantage may lie with big guns and thick plates, the guns and torpedoes of a ship may be fought on either side or both sides against superior forces; but with three rams seeking to destroy two rams, nothing but greatly superior speed or skill can equalize the combat.

It is most important that the Captain of every fighting ship, more especially of a ram, should be favourably placed and adequately protected when conning his vessel. We have shown that in all attempts to ram, the opposing vessels must pass and re-pass each other at very close quarters, so close indeed, that we may presume that all persons exposed to the fire of machine-guns and rifles will rapidly be placed *hors de combat*. It is our deliberate opinion that fairly roomy conning towers, well plated, or at least made proof against machine-gun fire, should be placed amidships in every ship, about one-third the length of the ship from the bow, and commanding a good all-round view; in this the Captain and Navigating Officer should be placed, while immediately underneath them, and well armoured and protected, should be the steam steering wheel, and all communications with the engine-rooms, guns, magazines, torpedoes, &c. It would be absolutely impossible to effectively conn a ship in action from the after-bridge. All ships are best conned from the place on which they pivot in response to their helm, to successfully use or avoid the ram or the locomotive torpedo. A full view of the enemy should be obtained over the bow.

The ram is in every sense a weapon of attack, it is in no sense a defensive weapon.

In another part of our essay we shall attempt to show how the attack of rams may be frustrated or deterred by torpedoes, but in this chapter we purpose to confine ourselves to the exhibition of the power of the ram as a weapon. To further do so, let us picture to ourselves the sudden meeting during a war of two steamers at night. They would come upon each other suddenly and probably unexpectedly, there is no time for private signals to pass; each vessel hurries to quarters; steam is ordered for full speed in both ships; each Captain feels that if he could be sure the other was an enemy that he could sink him before a gun was fired. What an opportunity for that Captain who had good reason to be sure that the other vessel could only be a foe!

The slowness and uncertainty of private night signals would be awful under such circumstances.

Do not let us lose sight of the fact that a blow from the bow of any of our merchant steamers driven at sufficient speed would either sink or disable most men-of-war.

How are our Captains to avoid placing their ships in danger of such a catastrophe?

Will it be the duty of a steamer on first meeting another at night to turn from her at speed until a private signal is answered or dis-

regarded? or should she close on the stranger's beam and hail as of yore? All these are questions the ram has forced upon us; they require to be carefully studied and worked out during times of peace.

In most cases of hostile vessels meeting at night the decision as to who will be rammer or rammee must be prompt, sharp, and decisive. What applies to a single ship in this matter applies much more forcibly to both squadrons or fleets. A hostile fleet caught or surprised at anchor or with low steam, is a fleet lost.

Before quitting the ram, we think we may here fittingly say a few words as to the construction of ram bows, having reference more especially to large armour-plated or battle-ships. Annexed are drawings of the rams of our "Collingwood" and the French "Amiral Duperré;" where there is so much difference in the design and contour of the bow, it may fairly be taken as a matter for criticism which is better or worse than the other (see Plate XI, Figs. I and II).

To begin the argument, we will frankly admit that undoubtedly a fair blow from either type would be effective against the side of any antagonist, but with two ships, each manœuvring to ram one another, the blows will not be delivered at right angles to the keel of the enemy, but probably at very oblique angles with each ship moving at a high speed; in any case when the ram of one vessel has struck the other and has penetrated her side, it will be at once exposed to severe lateral and wrenching strains, under whose influence, if the ram be not of sufficient strength to slew the ship before yielding, it will surely twist and perhaps be wrenched off. We will for the moment say nothing as to the effect on the ship rammed, but concern ourselves only with the rammer.

The instances we have to guide us are the collisions of the "Osprey" and "Amazon," when the latter rammed and then sank. She, it is true, was only a wooden ship with a weak ram, but she rammed a weak ship. Later, the "König Wilhelm" and "Grosser Kurfurst," the former being only saved by her watertight bulkheads, the ram being both damaged and twisted; later, again, the "Defence" and "Valiant;" here the blow of the ram was very oblique, and it suffered more than the side of the rammed ship; being of very weak construction the stem itself was fractured in two places.

Turning now to our Diagrams, Figs. I and II, let us compare the shape of the "Collingwood's" bow and the ram that arms it with that of the "Duperré," then briefly sum up the merits or defects of either as they appear to us. We grant first, as we have said before, that either ram would be sufficient to waterlog or sink a similar vessel if a fair blow were struck "end-on" to broadside at any speed over 8 or 9 knots; let us, then, in imagination consider this blow struck, and discuss its effect on the rammer.

It is evident that in the case of the "Duperré's" ram much greater penetration would be effected, her receding cutwater would penetrate farther, more easily, and with less shock to herself. The ram of the "Collingwood" would penetrate with equal ease until the vertical stem came into contact with the armour plates of her foe, when it is

not unreasonable to suppose that she would be stopped more abruptly and with greater damage to herself than the "Duperré." Vide Figs. I, II, and III.

Again, at lower speeds the sharp and ripping ram of the "Duperré" would have to our mind a decided advantage over the shorter and blunter ram of the "Collingwood," it would be more likely to effect penetration when an oblique blow was struck, and it would from its length and greater projection under water be more likely to strike and damage the rudder and screws of an adversary, having a far better chance of getting under a projecting counter.

As to the comparative strength of the two types of ram which we are now considering, we offer our opinion with much diffidence, but we feel constrained to say that we again prefer the bow of the French vessel; in the first place we like the armour extending to the point of the ram; we know that it is argued that the armour so extended does not contribute to the actual penetrative strength of the ram itself; even admitting that it does not do so, yet it must certainly render the point of the ram less liable to injury from shot or shell, and the protection it will afford to the thin bottom plating against lateral strains after the ram has pierced the bottom of any enemy is not to be undervalued; the sudden wrenching strain that must fall upon the ram of a heavy ship after striking an enemy in rapid motion must be enormous. We do not attempt to deny that the ram of the "Collingwood" must derive great support against such strains from the extension of the armoured deck to the extremity of the ram, but great as this may be, can it save the thin side plating from injury?

Then, again, in these days of large double bottoms, wing passages, and other minute internal subdivisions of ships, it may be fairly argued that a long and extended ram is likely to inflict greater injury than a short one. An idea is prevalent with some people that a ship with a long ram might on ramming penetrate too far into the side of another vessel, and that the ramming ship being unable to back out and clear herself might share the fate she inflicted on her enemy; there never was a greater fallacy; hitherto in every case of ramming or collision the striking ship has had no difficulty in rapidly clearing herself by backing her engines. We have personally conversed with some of the Officers of the Austrian armoured wooden frigate that sank the "Re d'Italia" at Lissa; they all stated the shock to be slight, and said there was not the least difficulty in backing out to renew the blow. We have heard similar statements from an Officer of the "Iron Duke" after she rammed the "Vanguard," and quite recently we have seen an iron steamer that had a few hours before at night steamed into the middle of a large barque, not stopping until she had penetrated the unlucky vessel as far as her (the steamer's) foremast, backing out at once before the barque sank, the only visible injury to the steamer being a few scratches on the paint on each bow, made by the crushed timbers of the riven vessel.

Every vessel of decent speed, large or small, should have a ram bow, which though of necessity in some cases too slight in construc-

tion to be used against a heavy ship, yet might always be sufficiently strong to be advantageously used against vessels of considerable size.

We were much taken some time back, by a remark made by Captain Gerard Noel, R.N.; he then stated—if our memory does not fail us—that in regard to lateral and wrenching strains the U-shaped bow was probably superior and better adapted to give strength to the ram than the V-shaped bow; we entirely coincide with his opinion in this matter.

Let us conclude this chapter on the ram by asking what is the best defence against it? The answer will be high speed and rapid manœuvring power; but these qualities are to some extent antagonistic to each other: true, then let us have high speed first combined with the best turning power that can be obtained in addition to it.

To mitigate as far as possible the fatal effects of being rammed, large double bottoms, ample wing passages, fore and aft bulkheads, and many watertight compartments are absolute necessities; no war vessel can be pronounced efficient unless she is so constructed. Also it will be wise to keep the outside of the ship as flush as possible, avoiding all weak projections, &c., &c.; anchors, guns, &c., should be kept well inboard; as we have shown before, two vessels rushing past each other end-on having failed to ram, would make a clean sweep of all outside hamper.

Chapter III.—*The Torpedo.*

We propose to limit our remarks in this chapter to an exposition of the value we attach to the locomotive torpedo only, meaning by the term "locomotive," those torpedoes which are either automotive by reason of having motive force stored within themselves, or which are propelled by the velocity of the ship or boat that is armed with them, or those which by some other means can acquire a motive power, reserving all notice of the stationary or torpid submarine mine for another page; the locomotive torpedo will be in nearly every instance used as an aggressive or offensive weapon, while the submarine mine, often miscalled as it is, a torpedo, may be correctly characterised as a strictly defensive weapon, its use being solely confined to the purposes of defence.

Treading very closely on the heels of the ram the locomotive torpedo promises conjointly with it to revolutionize the whole system of naval warfare; there is a similarity about the uses of the ram and the locomotive torpedo, indeed the latter has been not inaptly compared to a flexible extension of a ship's ram.

In actual warfare it will be proved on many occasions that the locomotive torpedo will ignore the power of the strongest, the heaviest armed, and most formidable ship that the laborious ingenuity of man can produce, and reduce it down to the level of the smallest, and we may even add the most fragile of her antagonists.

On close enquiry, however, it appears that it is not so much what actually has been done in the way of destroying large and costly

vessels by smaller and less costly craft, but what is expected to be done in this way in the future, that hastens all nations to not only re-arm their larger vessels, but to create in addition to them a numerous flotilla of small swift vessels, all to be armed with offensive torpedoes as their principal, if not only, weapons.

It is needless for us to say much concerning submarine boats in our essay; their success has so far been exceedingly limited, for although several nations have attempted their use and development, they have all more or less failed, and we believe that with only one exception, these "Davids" or submarine boats, have in actual war, or in experiment, generally succeeded in drowning their own crews before doing much practical service; we are not, however, rash enough to say that if certain difficulties concerning their total immersion can be overcome, and more especially if stored electricity can be applied as their motive power, that there may not yet be a future for these under-water craft, admirably adapted as they would be for efficiently discharging locomotive torpedoes without an enemy having the least suspicion of their immediate proximity; we feel, however, that we are quite justified in disregarding the use of submarine vessels at least as far as their employment would affect the naval warfare of to-day, there are, as yet, no changes in its conditions due to the employment of such craft.

The best known of all locomotive or automotive torpedoes is "the Whitehead;" there are in addition to it "the Lay," "the Brennan," "the Sims," "the Berdan," and others; of these the Whitehead alone can at the present time be pronounced adapted for use as a seagoing offensive weapon.

This beautiful and fish-like torpedo, when skilfully handled by those well trained to its use, becomes a swift and deadly under-water projectile; its beautiful and ingenious mechanism once correctly adjusted requires no further guidance from the hand that launches it; equally effective whether launched from ship, boat, or shore, it is capable of carrying its destructive charge of 65 lbs. of guncotton to a distance of 800 yards at a speed exceeding 22 knots an hour; it can also be regulated so as to travel nearly a mile at a slower speed before its motive power of compressed air is entirely expended. At such a long range its practice must necessarily be somewhat uncertain, but when limited to the shorter range and started at the high speed first mentioned, and in smooth water, with little or well estimated current, it is a weapon that may well be dreaded by the large and costly armour-clads of to-day; which can by its agency be disabled, or even be destroyed, almost before they have become aware of the near presence of their destroyers.

Here there can be no prospect of a fair and open combat, we can have no ship matched against ship, gun returning gun: no! the insidious approach of a swift torpedo-boat may, especially at night or during a fog, prove that for once the weak are strong, and that at times the strong are impotent.

We regard the Whitehead torpedo as more essentially the weapon for light and swift vessels; it is true that they can also be effectively

discharged from heavy vessels, but there is always a remote danger of the torpedo not getting clear away, perhaps from bad management, or in a heavy seaway, thus admitting the possibility of some valuable vessel being "hoisted with her own petard;" recent improvements in the Whitehead have, however, rendered such an accident exceedingly remote.

There is, we fear, much danger to be apprehended from an indiscriminate use of the Whitehead torpedo in a fleet action; here it may, if carelessly discharged, as easily destroy a friend as a foe. Moreover, we believe that considerable risk is run from the liability of an inboard explosion, especially when the torpedo is placed above water, and is in readiness for launching, from the effect of machine-gun fire, shell exploded in the vicinity, &c., &c.

The Whitehead torpedo is not likely to be effective in a heavy sea: it may when launched under such conditions from above water keep its course straight enough, but we doubt its preserving its proper depth; the weak point of the Whitehead is the extreme undulations it often makes below the surface when first started, in a heavy sea it could not well run either on or near the surface.

A first acquaintance with the value and merits of the Whitehead torpedo would lead to the not unnatural belief that the general and extended use and adoption of such a weapon would have a strong tendency to reduce that nation who is most powerful at sea, and who has hitherto trusted to the general prowess and invulnerability of her armoured ships, down to a nearer equality with previously weaker maritime nations; if the study and practice of locomotive torpedoes is neglected by us, we have already acknowledged that this may be so. But farther on in our essay we shall endeavour to prove that if we in England do not stand still, but, on the contrary, boldly face the general adoption of locomotive torpedoes as novel but potent factors in naval warfare, then, instead of their use being very much to our disadvantage, we may even make them contributory to the support of our great naval power: certainly they will add largely to the protective strength of our Colonies.

The outrigger, or spar torpedo, can alone depend for its locomotive power on the speed of the vessel which is armed with it; whether carried at the end of an outrigged spar in the bow of a boat, or from the end of a boom in a larger vessel, it may be with justice, in either case, pronounced a most formidable addition to the weapons of naval war. Already its bold use from boats has commanded many and great successes, while its employment when extended from the end of a boom in large ships may in the future lead to some very remarkable results.

Controlled by electricity instead of by a fuse, the spar torpedo has become a safe and docile weapon, which when wielded by the bold and courageous seaman, can be terribly destructive to the largest vessels.

It is true that for the rapid and swift torpedo-boat the superior advantages of the Whitehead have theoretically displaced it, but it is well to remember that while the outrigger weapon has scored many

and great successes, the Whitehead has as yet not had one definite success in actual war.

The disadvantages inherent to the spar torpedo are that the poles are cumbersome and liable to bend or even to break when they are submerged if the boat is going at high speed, thus necessitating a slower attack than with the Whitehead; when rigged out they will of themselves much reduce the boat's speed; also, the attack having to be made in close proximity to the side of an enemy, the danger to the crew of the torpedo-boat must necessarily be very great, while excellent practice can be made with the Whitehead at even 500 yards distance; again, it is far easier to rig temporary defences to guard against the attack of a spar torpedo than against the Whitehead; nevertheless, despite these disadvantages, the outrigger torpedo is to our mind fully the equal of the Whitehead in other ways; it is a weapon well suited to an impromptu attack, and cannot be superseded as a formidable weapon in the hands of a daring and capable Officer. Unlike the Whitehead, it is not a costly weapon, it will seldom fail, it requires less instruction to learn its uses; lacking a supply of Whiteheads, a modern man-of-war can with her own materials and resources construct in a very short space of time a fairly serviceable outrigger torpedo.

The darkest night or the densest fog affords the best opportunity for the use of the spar torpedo; under such conditions it should always excel the Whitehead, for there will be no liability to misjudge the distance or the force of a current; the blow, when dealt with courage, will be struck home with no chance of failure.

The comparative merits of the Whitehead and spar torpedoes have been aptly rendered in the following words; we quote them, for we feel that we could not better the lucid illustration which they give.[1] "The spar torpedo is the dagger which, at the risk of his life, a determined man will plunge into the heart of his enemy. The Whitehead torpedo is the bullet that can easily be projected from afar, and can kill the enemy on its path, but which also will often miss the object aimed at."

In the event of a fight between two boats, the one armed with the outrigger, or pole torpedo, the other with the Whitehead, it appears that the former would have the best chance; it would be no use discharging a Whitehead at a small boat, but the boat with the pole could keep her pole facing her enemy, who dare not approach it too closely.

The outrigger torpedo is also certainly very formidable when extended from the boom of a big ship. Being completely under the control of the operator, electricity has converted it from a very unsafe to an absolutely safe weapon; there is now no danger should it fall alongside of a premature explosion, injuring its own vessel; nothing can explode it until it is brought into actual contact with an enemy, then the eager and willing but equally docile electric current is released, and the charge fired.

[1] *Vide* Brassey, vol. ii, p. 191.

Towing torpedoes have well nigh had their day; the difficulty of working them, and the necessity of exposing the men who do so to the full fire of the enemy, has all but terminated their existence. Harvey's towing and diverging torpedo was tried and was for some time in use in Her Majesty's Navy; the French also made use of a somewhat similar weapon, but were not satisfied with it. The Whitehead, indeed, seems to have quite displaced it in all countries.

The use of towing torpedoes cannot but be attended with considerable risk to those who tow them, there is always the contingency of the wire tow lines fouling the propeller; they also largely detract from the speed of small vessels, and much restrict their power of rapidly manœuvring, and frequent experiments conclusively proved that it required the greatest skill, judgment, and good seamanship to successfully place one in contact with the bottom of an enemy's vessel.

In fleet actions where well preserved close order would of itself be a large element of success, the use of towing torpedoes becomes an absolute impossibility. The only occasion when, we think, it might be justifiable for a Captain to use a towing torpedo, would be when he knew that the superior speed and turning power of an antagonist made it almost certain that he would get his ship rammed; in such a case, and then only, we believe that a torpedo towed astern might serve to embarrass his enemy, more than it encumbered his own movements.

The Lay locomotive torpedo, controllable and self-propelling though it may be, is yet not to our mind a seagoing weapon; we have the strongest doubts as to the practicability of any torpedo which when started from a vessel requires attachments to her, as the Lay does, to guide it on its course. Here what might prove an advantage to it if fired from the shore becomes fatal to its success when used with a ship or ships in rapid motion. The speed of the Lay torpedo is, at present, slow; and we also object to the way its motive power is derived, especially for ship use. It is reasonable, however, to suppose, judging at least from the nature of the reported experiments, which we have read, that this torpedo may be of service when the Whitehead is not available. Started from the shore, where its great weight may be less inconvenient than it would be afloat, the heavy bursting charge which it carries would prove exceedingly destructive. The Russians and Turks are both supposed to have made successful experiments in its use, but at present we do not think it can be fairly claimed by those who advocate the Lay torpedo that it will be a factor in modern naval wars.

The other locomotive torpedoes, viz., the Brennan,[1] the Ericsson, the Sims, &c., we have had no opportunity of studying, it would appear that they are yet in their infancy; but we admit, without hesitation, that if the locomotive torpedo should succeed in maintaining during a war even a part of the great *prestige* that it has

[1] We had written this before the successes of the Brennan torpedo were made public. In the face of its remarkable success we still do not think it a weapon generally adapted to naval use.

advanced in peace, then that the Whitehead will have to face many rivals, as well as improved types of Lay, Brennan, and Ericsson torpedoes, over which it is at present, for naval purposes, actually paramount.

We understand that it is in contemplation by foreign Powers to have batteries of Whitehead torpedoes arranged for the defence of the narrow entrances to some of their ports; placed beneath the water and under the cover of guns, these Whitehead batteries are to be capable of discharging their torpedoes either in flights, or singly, at the discretion of an operator who would be unexposed and acting in perfect safety, it would be akin to madness to wantonly expose valuable armour-clads to the risk of such an assault.[1]

In assigning a proper value to the torpedo, we should do well to bear in mind that with the exception of some chance shot it requires a very considerable amount of hitting, and a very much greater amount of firing from guns, to disable a ship entirely, also that the blow from the ram may be deflected if it happens to strike obliquely; but the torpedo, if well aimed in any sort of contact with a ship's bottom, must be absolutely fatal to her further fighting efficiency; for instance, it was recently proved, at some experiments in Sweden, that 33 lbs. of dynamite exploded at a distance of 4 feet from a well-built target, representing the bottom of the "Hercules," blew a hole in the inner skin some 70 square feet in area.

There can be no doubt that in actual warfare the locomotive torpedo will in the future further demonstrate its tremendous powers of destruction.

High speed and great mobility seem to be the only tolerably effective safeguards against such a terrible weapon.

CHAPTER IV.—*The Submarine Mine.*

Under this heading we propose very briefly to say a few words concerning those mines which are submerged and stationary, and which, though they are torpedoes in the first acceptation of the term, are now for the sake of distinction more generally designated as submarine mines. When compared with their locomotive and automatous brethren they are no novelty, submarine mines of a rude type having been employed years ago.

Submarine mines, when in position and submerged ready for service, either rest on the bottom by the force of their own gravity, or they are moored by anchors or weights; the greatest difficulty is experienced in keeping them at the proper depth, especially when there is a large rise and fall of the tide; we believe, however, that a recent clever invention has made the submarine mine of the future self-acting and capable of automatically preserving its proper depth.

[1] We have omitted to mention the coal torpedo. This base and cowardly weapon has been, and may be again used in naval warfare, though it is more appropriately the instrument of the Fenian and "dynamiter," than the civilized nations of to-day.

The original submarine mine was entirely mechanical in its action, the explosive with which it was charged being ignited by the shock of some passing vessel striking the mine and putting the firing mechanism in action; these purely mechanical mines were dangerous alike to friend and foe; great ingenuity has been exercised in perfecting the firing mechanism, and there are many plans that have been practically tested in actual warfare. Mechanical mines were largely submerged by the Russians in 1854 and 1855, by the Confederate States during the Civil War in America, and still later by other nations; they have scored some great successes, but being dangerous, both to lay down and to remove, their true motto is "Nemo me impune lacessit;" for this reason their use is being much restricted and will probably be altogether discontinued.

The more scientific submarine mine of the present day is exploded by electricity and is far in advance of its older prototype; being at the pleasure of its operator either mechanical or at will fired by two observers stationed on the shore, they are perfectly safe to passing friends; they can also be laid down or removed by their owners without the least danger if proper precautions be observed.

The modern submarine mines that are fired by electricity may be divided into three classes:—

The "electric mine," which depends on two observers, each at a different station, noting that a vessel is close to a mine, and who, by jointly completing the electric circuit at their respective stations, explode the mines; this is sometimes called an observation mine.

The "electric contact mine," which can be either fired as above, or explodes on being struck by some vessel; this system, advantageous as it is, involves many complications and renders the mines difficult to test, but has the very positive advantage of being self-acting during night or fog, when the trespassing vessels would be hidden from the observers.

The "electro-mechanical mines," which have a small battery contained in them, and which is used to explode them, are, however, quite as dangerous to handle as the old mechanical mines before described.

Drifting torpedoes, or submarine mines, were employed against our ships in the old Chinese war; and also very lately by the Peruvians, who, by means of mines concealed in drifting boats, blew up two Chilian vessels; many daring and crafty stratagems will be tried during the next war on similar principles.

The proper function of the submarine mine in future naval warfare will be the protection of ports and harbours against the sudden inroads or aggressions of an enemy; when securely placed under observation and supported by the fire of batteries, mines become most formidable, and their maximum defensive power is reached; otherwise, their effect on the shipping of an enemy is known to be chiefly moral and deterrent, and their removal or destruction becomes only a matter of detail, time, and caution.

No attack that has been carried out with determination by ships against a passage solely defended by submarine mines, or even defended by mines that are only weakly supported by guns, has ever

failed; the mines have delayed the ships and have inflicted some very severe lessons on those who first sought to pass them; but taken as a result the mines have always been beaten; we think they always will be; in proof of this assertion, we draw attention to the attack of the Federal ships on several of the Confederate ports and rivers; and later still to the naval part of the war between Brazil and Paraguay. It is true that the mines never failed to exact some severe penalties from the ships; in the first quoted attacks the Federals at different periods lost seven armoured vessels, mostly monitors, besides eleven unarmoured craft, all blown up or sunk by the action of what we should now call very primitive submarine mines; in addition to these casualties, several other vessels were at odd times injured and temporarily disabled from submarine explosives; but all the same, history records that the ships were not kept out.

In the Brazilian and Paraguayan war to which we have just alluded, an armour-clad vessel of the former nation was, while making an attack on a fort, broken almost in two by the explosion of a submarine mine, sinking at once with most of her crew; daunted but not deterred by this disaster, the Brazilian fleet eventually overcame both the mines and the batteries that supported them.

We have also already alluded to the destruction of two Chilian vessels by mines concealed by the Peruvians in drifting and apparently abandoned boats which on being hoisted up or roughly overhauled exploded, at once destroying their Chilian captors. A lamentable want of caution was exhibited by the Chilians, in both instances they had actually been forewarned but were over-confident; in future, all drifting boats should be examined at a safe distance from the ship, and no strange shore boat should be allowed near without being first boarded and overhauled.

There can be no manner of doubt that electric submarine mines will, during the next war, largely enter into the defence of all seaports, and that when their removal is actually necessary in order to force the entrance to a port, special ships will be employed to effect it; of these vessels we shall say something in a later chapter.

But stationary submarine mines will not be alone of use for the defence of ports and rivers, on many occasions they will be of much service to the blockading ships, who can lay a line or two of mines outside the defensive mines of the place, and thus close all egress and save themselves much anxious watching and care.

Submarine mines will be invaluable as harbour defences to our outlying and sparsely populated Colonies, and may save them from bombardment or from paying tribute to the sudden visit of some hostile cruizer who could not well waste the time off the port that would be necessary to remove the mines.

So far in our essay we have confined ourselves to explanatory details concerning the novel weapons that will be used in the naval warfare of to-day; we have done so in the endeavour to simplify the latter part, by at first exhibiting the values we attach to the ram, the torpedo, and the submarine mine; we hope thus to be more explicit and also to free our following chapters from much explanatory matter

with which, had we done otherwise, we should have been compelled to interlard them.

We have also up to the present purposely omitted direct reference to the improvements in naval ordnance, quick-firing and machine-guns, torpedo-nets, torpedo-hunters, &c.; they are all of course intimately connected with the attack and defence of ships, and enter largely into the changed conditions of modern naval warfare. We think, however, that we shall deal with them in a more effective and more appropriate manner if we reserve our ideas as to their employment for our later chapters, more especially for those chapters in which we shall deal exclusively with the attack and defence of ships and harbours.

Chapter V.—*Training of Personnel.*

We infer from the text of our essay that the question of training personnel with which we are required to deal, is that which mainly applies to the use of the ram, the torpedo, and the submarine mine; but after much thought and a close examination of the matter, we find the connection between the general education of both Officers and men in seamanship, gunnery, ramming, and torpedo work to be so intimate, that it is impossible to deal effectively with the subject if any distinct separation be made.

Surely it will be on good seamanship alone that we must rely, so that our rams and locomotive torpedoes are successfully handled, or those of an enemy avoided; it will certainly only be by seamanship of a high order that a dangerous channel is cleared of submarine mines; it will be by good seamanship and gunnery combined that the attack of a flotilla of torpedo-boats is beaten off or frustrated; and it can only be by a fleet manned by Officers and seamen who are well trained in all the above that a blockade could be established and maintained.

This being so, we crave some indulgence from the referees to whom our essay will be submitted, if they should consider that we have in any way strayed outside the limitations of the subject as imposed by the Council of the Royal United Service Institution.

It has been sensibly remarked, and it would be hard to contradict the truth of the assertion, that in the present day no amount of matériel, even if it be of immensely preponderating power, can be of proper value as a fighting quantity unless it be manned and worked by a well trained and courageous personnel.

Let us take it for granted then that the first requirement of a naval Power—a naval Power we will say to whom the freedom of the seas is an absolute necessity—will be a highly educated and disciplined body of naval Officers and seamen; a body of Officers so fully educated as to embrace the arduous duties of their profession from no narrow point of view, but with all the vigour of a well trained and cultured intellect; a body of seamen who from being inured to the sea have had their manliness and bodily activity improved and strengthened, and their nerves and courage hardened by the daily vicissitudes of a sea life, and yet withal possessing sufficient educated

intelligence to grasp with ease the more simple portion of modern scientific naval warfare.

For our blue-jackets then we would have, if we could, the daring and hardihood of the seamen of old, or sailors, as they might then be equally correctly denominated, grafted on the wit and intelligence of our modern seaman gun and torpedo man, then perhaps we might have a perfect article; but it is absolutely impossible that we can have such a profound combination of excellence, the daily routine and life on board our latest steam man-of-war utterly and entirely prevents such an alliance of good qualities. It has been well said that it is just as impracticable to expect the seaman of to-day to be the old salt of bygone days, as it would be to expect the latter to fulfil the duties of the valuable seamen of these days of high pressure and rapid transition; it is impossible! the race of men is too entirely different, and we may be thankful that it is so. The older type of seaman, with his extreme repugnance to drill and his happy-go-lucky but generous nature, would be of little service to us, holding us, as he probably would, in supreme contempt as a something lot of lubbers. Could he take our place? No, most certainly not; the transition from sail to steam would have been too abrupt for him; let us, as we have said before, be thankful that it is so, and fully recognize the fact that the wise means adopted by the State for training our young seamen has given us a valuable if not in all classes a sufficiently numerous body of men wherewith to fight our sea battles of the future. So let us, and those who follow us, endeavour to ensure in future that our methods of training and educating our young seamen shall change and keep pace with the times, thus making our coming seamen efficient for the work they will have to do, wisely omitting from their course of instruction all that is rapidly becoming obsolete, and adhering in far greater measure to the production of a seaman, not necessarily a sailor, who is well able to take part in the skilled warfare of this era of steam and explosives.

It might be right here to say that the improvement in the whole tone and character of our men-of-war's men of to-day is due in great measure to the skill and ability with which the boys' training-ships have been organized and conducted, we have little to say that would be worth saying as to improving the training of our blue-jackets until after they leave the training-ship; perhaps some obsolete sailorizing still remains in the course of instruction, the time given to which might be as well or better devoted to the acquirement of more useful matter; but where our system fails is, that after well heating our iron we do not keep it hot; having completed their training in the training-ships, the lads ought at once to be sent to ships in which they would have a fair chance of keeping up what they have learnt instead of going to a harbour depôt ship, or a mastless armour-clad, they should have the benefit of at least two or three years' sea-work before being exposed to the demoralizing influence of a harbour ship.

Much that we have said of the man equally applies to his Officer. Our glorious naval history proves that our naval Officers have always been men in advance of their day, and it is to this fact as much as to

the excellence of our seamen that we enjoy our present high naval *prestige*.

But does the embryo naval Officer of to-day start on the same footing of equality as regards the acquirement of his professional knowledge as his predecessor did in those days when our Navy achieved such glory?

Yes, in theory he has a far better chance than they had, but in practice, no. They, without any preliminary training, became from long cruizing, constant sea-work, &c., after much hardship, absolute masters of their profession; it was truly a hard course, from the early dipping of hands into the tar bucket to the long and severe cruizes on a limited supply of water and constant salt provisions; daily encountering or watching for the enemy; constantly battling with the wind and weather; this made the man what he was. Let us mark this result, for it contains a lesson to us. It should teach us that with all the theoretical education which we can and do give our young Officers, they will yet be inefficient unless we give them plenty of sea-work, and let them thoroughly acquire the practice as well as the theory of their profession. Let us boldly face the fact, that although now-a-days we don't want to, and indeed cannot, make our Officers sailors in the sense that they should thoroughly understand the use of masts and sails, yet that we do want them to become practical seamen, and that we know they have three times as much to learn as they had in days gone by.

If an Officer has become a thorough seaman in addition to having a good knowledge of the means used to conduct the scientific warfare of the day, we may rest content that we have got a man who may be of inestimable service to his country, and who, should the opportunity occur, would generously repay this country for giving him so ample and costly a course of training.

The question now arises as to how this course of training is to be given. It is a question that has been often and well discussed, and by wiser heads than ours, and recently, but that shall not deter us from adding our voice to that of those who have raised theirs on a matter which so deeply concerns the welfare of the nation. We are fully imbued with the stern necessity that exists for making our naval education march with and abreast of those rapid changes which are daily being made in naval warfare, and we are conscious that our ideas are well meant, and we are not ashamed of them, even if they are thought devoid of value.

To begin, we will assume that the merits of any system of naval education will become most apparent as the Officers whom it has trained and developed reach first the bottom and then the middle of the Lieutenants' list; until an Officer has become a Lieutenant of from three to five years' seniority we say that he is still daily and rapidly imbibing professional knowledge and experience, gradually, in fact, harmonizing theory with practice; we do not attempt to say that he will not also learn much after passing the periods we have named; on the contrary, we say that he undoubtedly will still learn much; the naval education of to-day can never cease; but we do

say that when a Lieutenant reaches three years' seniority, then his individual value, and the value of the system by which he has been trained, can be well and fairly estimated and judged; by that time he should be at least impressed with a sense of his own great and coming responsibility, and his Captain should be able to accurately predict what his future will be, whether he is to be a capable and rising Officer, or the reverse.

Before we carry our argument any further, we admit without hesitation that our present system, faulty or not faulty as it may be, has borne good fruit; we believe that the Officers now comprised on the Lieutenants' list of the Royal Navy are as good or better than at any former period, and we are convinced that they will bear favourable comparison with the Lieutenants of other navies; sailors they may not all be, we are sure that the majority of them are or will be good seamen, and that they possess both the pluck and ability to nobly uphold the honour of their country whensoever they may be called upon to do so.

Having admitted so much, we shall yet have the temerity to suggest certain changes, which have in our opinion become and are daily becoming more necessary.

What we say must of necessity be brief, our allotted space forbids our going more fully into the subject; we are, as we have said before, unable to separate the education necessary to the accomplished use of the ram and torpedo from the general education necessary to make an Officer and seaman; the use of those weapons must be a part and parcel of our whole system, and will contribute to our success in the future as the skilled handling of a vessel under sail did to the achievement of our former naval victories.

In the first place we venture to say that in connection with our text we at present enter our naval cadet too young; if we allowed him to remain at school another two years or so, each lad ought to join the Service with a good mathematical knowledge, indeed we are sure it is better for him to remain at school until he is sixteen, or at least fifteen and a half years old; we are quite at a loss to see why the country should be at the expense of providing the embryo naval Officer in the mathematical and other studies which are necessary in every way, which can be best learnt at school. And we detest the system that places the lad's studies in conflict with and thus diminishes his chance of learning to be a seaman, and in great measure prevents his acquiring anything but a theoretical knowledge of the general minutiæ of routine, order, and discipline, that are coexistent with smartness and comfort in every man-of-war.

Let us propose, then, that after a limited competitive examination, we should start our cadet on board the "Britannia" at the youngest between fourteen and fifteen years of age, and thence we would address ourselves to the task of making the lad not only keep up, but advance in what he has already learnt, still devoting much more time than at present to pushing him on in the rudiments of navigation and seamanship, with a fair knowledge of the working of the steam-engine, keeping him here for a year or eighteen months, and, finally,

during the last three months putting him through a course of electricity as applied to torpedo warfare, combined with plenty of instruction in manœuvring boats under steam and sail.

Taking the boy thus later in life will, we think, not only prove an economy to the country but better for the lad, who, we are sure, thrives and physically develops faster at school than afloat; then at the expiration of his eighteen months' course in the "Britannia," a youth at the age of seventeen or perhaps eighteen years is far better able to take his place as an efficient fighting unit in a fighting ship, than he would at an earlier and more tender age; we must not forget the serious reduction that has taken place in the fighting portion of our crews of late years; anything that tends to raise this strength must be of undoubted value; we are greatly handicapped on this head when compared with the navies of other Powers, partly from the fact of our having in some ships so many young midshipmen, and also from the large proportion of the non-combatant element to be found in every vessel.

On our cadet leaving the "Britannia" or College at the age we have mentioned, and on the completion of his course there, we still would not send him in time of peace at once to a fighting ship, but would embark him with his fellows in a corvette for some six or eight months, this vessel to be constantly cruizing and visiting foreign ports, practical seamanship and pilotage being his principal studies. At the expiration of this course, the lad being then seventeen or eighteen years of age, should join a seagoing man-of-war for two years, where he should be made of some use and not have his whole day devoted to the study of his books, but to learning practical seamanship, keeping day-watch under the Lieutenant, and gunnery and torpedo work; he should be a close attendant and observer of every evolution and help in all torpedo exercises. At the age of nineteen and a half, provided he had served two years in a seagoing ship, he should be allowed to pass an examination in seamanship, as he now does, before three Captains, this examination to be greatly altered and modified, several of the examination forms being quite twenty-five years behind the times, and no mention being made of the theory or practice of ramming. On his passing, the country must make up its mind to lose the services of its young Officer for nearly two years, during which time he will be fully employed in studying and preparing to pass his four other examinations, viz., navigation, gunnery, pilotage, and torpedo.

We do not like the term "navigation" as it is now understood; to take a first class in it not only means that the Officer who has done so is well up in navigation, but that he has passed in mathematics up to a very high standard; another Officer who may perhaps be equally well up in practical or even theoretical navigation, owing to his inability to become a high class mathematician must be content to receive a second or third class certificate. Now we do not mean to dispute the fact that the man who passes the best examination in mathematics is not perhaps the best man all round as well, but we do say that it is unfair to make a high knowledge of mathematics govern the examination in navigation any more than it does in the other three subjects.

We think that the high standard examination in mathematics should be optional, and confined to those men who compete for five firsts, or that there should be separate subjects, *i.e.*, mathematics and navigation, a moderate knowledge of mathematics being made compulsory in any case.

A Sub-Lieutenant on completing his examination should be hurried to sea at once, and promoted as at present, the class of certificate he has taken being duly considered when the selections are being made.

It will be for the benefit of the Service that a newly promoted Lieutenant should at once go to sea and keep watch for a couple of years, unless he had exhibited any marked aptitude for the special duties of either Gunnery or Torpedo Lieutenant, when one year, but no less, might be sufficient.

At the expiration of two years those Officers who had taken good certificates might be allowed, at the recommendation of their Captains, to volunteer for the duties of Gunnery, Torpedo, or Navigating Lieutenant, and proceed to qualify according to their election.

There should be no half-pay for Lieutenants. Any time between ships should be spent at a naval port in the study of naval tactics, torpedo work, or gunnery.

At each home port constant courses of seagoing gunnery practice, torpedo exercise, and steam evolutions should be perpetually carried on, the latter course will be more useful to the young Officer than half the bookwork he has mastered, much of which he can and does forget, without prejudice to the Service; but if he cannot manœuvre a ship when in action the country will surely suffer. Having once grasped and mastered the art of manœuvring a vessel under steam, all steam tactics, every fleet evolution, and all sea-work generally will tend to keep his hand in.

How few Officers learn how to handle a ship until actually placed in command of one.

How many Captains will be placed *hors de combat* in the first half-hour of a naval battle? It is most necessary that every Lieutenant should have some experience in handling a ship.

We think that we have said enough to make our readers say, how do you propose to give this seagoing training to Officers and men both in seamanship and gunnery, as well as the more advanced course to teach the younger Lieutenants how to manœuvre a ship?

We fully foresee all the difficulties that hamper the question. We foresee the difficulty of finding suitable ships, we foresee the difficulty of finding the money, and we know there are others which we shall not mention.

But to make a beginning, we would abolish the present harbour depôt ships, we would lodge both Officers and men in barracks. Our harbour depôt ships are costly to keep up, they have no practical utility for the defence of our harbours, they are guard-ships in name only; the wants of the Navy are so great in proportion to the money voted to keep it efficient, that we cannot afford to keep one useless ship in commission. The Admiral's flag at the home ports should be flown at his own house, or from some serviceable vessel. This vessel

should be often fully manned from the barracks, and make frequent excursions outside the port for gunnery and torpedo work, Officers being sent to her from the gunnery and torpedo instruction ships for this purpose, as well as Officers and men from the barracks.

We would for the benefit of the Service abolish every harbour depôt ship, steam reserve ship and hulk, those ships that were not seagoing we would at once sell or break up; they now encumber our harbours and eat their heads off.

The work of the steam reserves should be done on shore, all supernumerary Officers and men to be lodged in barracks, where they not only go to wait appointment, but to be constantly drilled, instructed, and exercised.

A seagoing gunnery ship should be attached to both the "Excellent" and "Cambridge;" drafts of men from the barracks should go for short courses of instruction to these ships, where they would at sea fire at moving targets, &c. These two ships might be joined to the Reserve Squadron for its annual cruize, and in combination with torpedo-boats manned from the "Defiance" and "Vernon," night and day torpedo attack might be studied and practised; the gunnery people should be on their mettle to defend their ship, and the torpedo experts to attack them.

We would have no ship in commission that was not efficient and available as a fighting vessel. How much money is yearly spent in repairing, painting, watching, and keeping clean vessels that are absolutely dummies?

To each naval barrack we would attach a good gymnasium; by their use we could impart to our seamen some of the strength, self-confidence, and agility formerly acquired by them from handling sails and spars aloft.

It may be urged that we do not have as a rule sufficient men at the home ports to fill the barracks and keep up the course of drills we now propose. The only reply we can make to such an objection is that we ought to have them. We are not in a position to make war as a great Naval Power if we have not at least 5,000 seamen in hand, either at the home ports or on leave of absence from ships paid off; these men to be embarked before we commenced to draw on the reserves, and should not embrace any young seamen amongst their number, or as few as possible, the younger men to be kept at sea by every means in our power until they have completed five years' service.

We again fully admit all the difficulties in the way of carrying out our proposals, which through limited space we have somewhat abruptly made; but we say that they should always be kept in view as desirable, and that all changes that are made to improve the training of our seamen should tend towards their gradual fulfilment.

It may be asked, why do the depôt ships deteriorate our young seamen? On all sides it is admitted that they do so; it would appear that the men, knowing that they are only on the roster for draft, think more of the shore than the Service, and being on constant working and dockyard parties become slack and demoralized. In barracks we

think they would do better; it should be firmly stated that they go there for drill and instruction, the time wasted in cleaning and polishing the depôt ship would be gained.

The Channel and Mediterranean Squadrons are, and would remain, our great training and perfecting schools for both Officers and men; what we propose should be entirely supplementary to them. We submit, however, that for two months in every year each squadron should be principally occupied in offensive and defensive torpedo operations; one month in laying down and picking up submarine mines, defence of harbours, ships, and channels by stationary mines; the other month twenty torpedo-boats, and one or two torpedo-hunters, should be attached to either squadron, who would then be able to practise day and night torpedo attacks and fleet evolutions in conjunction with these fast boats: Officers of all ranks must benefit by such work.

It is a very great mistake to suppose that a Lieutenant taken off the bridge of a large ship, and placed in charge of a swift torpedo-boat, will at first be able to make efficient use of her; not only must he have time to get used to the peculiarities of these boats, their rapid loss of way when stopped, and the quickness with which they acquire a high speed when the engines are started, but he must have time to overcome the strange sense of lowness in the water, to get accustomed to an horizon of only two or three miles instead of eight, and the difficulty thereby of making a landfall, or picking up a ship of which he was in search.

To conduct a flotilla of torpedo-boats to the attack of ships at night is in itself an education; there are fifty wrinkles and dodges that will suggest themselves to the mind of a clever Officer when practised in making such attacks which he would never have dreamt of without. But it is not only in attacks of torpedo-boats that he must be exercised, the defence of ships by a counter-attack is equally necessary, torpedo-boat against torpedo-boat. Here, again, considerable practice in night-work is wanted; without constant practice the strangeness of the dark can never be overcome.

The value of a detached or flying squadron as a means of training Officers and men is undeniable, at present it would seem impossible to form one, the starved state of the Navy provides neither the ships nor the money to keep such a squadron going.[1]

While such an important factor in our naval training system is unobtainable, we ought to compensate the Service for its loss, by letting the Admirals on the different foreign stations assemble and exercise their whole squadrons together periodically. The healthy spirit of emulation that arises whenever ships are brought together, and worked against each other, must certainly increase the mutual knowledge of all, to say nothing of the fleet evolutions, signalling, look-out work, torpedo exercise, &c., that cannot well be done except in company with other ships: all would be beneficial.

At each of our gunnery establishments, in addition to the present

[1] We had written this two months prior to the formation of the present Flying Squadron.

very satisfactory course of training that our seamen gunners get, we persistently advocate a more severe course of instruction in firing heavy guns at sea against moving targets; stout well-built targets should be towed at a speed of say seven knots well astern of a gunboat or tug, the firing ship should pass and re-pass this target at high speeds. It is only in this way that a test can be applied to the value of certain men as captain of a gun or turret. Many men can make good shooting at a fixed target or from a ship steaming at slow speed, but they may utterly fail in taking those quick, almost snap shots at rapidly passing or approaching vessels, which will be so essential to success in future naval battles. With a heavy armament the number of guns in each ship must be limited, probably to four very heavy guns; the loading is slow, the opportunity of seeing the enemy infrequent, but all the same the value of a well-delivered shot is worth now one hundred times its former value, nay more, it may actually decide an action, or determine whether or not a ship be destroyed by swift ram or torpedo-boat. If this be so, can too much training be given to the man in whose power it may be to ensure such results? No, the seaman who as captain of a turret or big gun combines a well-trained hand and eye with nerve and judgment is worth any wages the country can give him, and he will liquidate the cost of his previous training by the accuracy of the first shot that he fires at an enemy.

Constant practice cannot alone give us this valuable specialist, but it will show us the man who is capable, and we should then do our best to perfect him. Very few men will be found up to the required mark; it is not, for instance, given to every one to be a good shot in the sporting field, while to others it is innate, hand and eye work together from the beginning.

These are the days of specialists, our future captains of heavy guns must be specialists.

In addition to the use of a seagoing gunnery ship and towing targets for selecting and training our captains of guns, most valuable instruction could be given in firing quick-firing and machine-guns at rapidly moving targets, while the value of such experience to the Officers who conn the firing ship would be great.

On all occasions opportunities should be seized to exercise in laying guns for rapidly passing objects in all ships. The stationary target is only good for a beginner, otherwise it is a thing of the last decade. With two steamships rushing round and past each other how and when can it be found?

Again we repeat that an extended course of training in seagoing torpedo work is an absolute necessity, not only for the experts, but for all Officers and men of a fleet, it can only be from constant familiarity in their actual use that locomotive torpedoes and submarine mines can be successfully worked either for attack or defence; they all contain a strong element of danger to the careless or unskilled who should strive to operate with them. All preliminary details as to the course of education to be pursued in our torpedo schools we are content to leave without remark in the hands of able

and intelligent Officers who have organized and conducted them with so much success.

The number of Officers who have been put through the course of instruction in our present torpedo schools, both on full and half-pay, speaks well for their future, and the further requirements of the Navy, as regards this highly scientific branch of modern warfare, may with safety be left in the competent hands who preside over them.

We in England are not, however, alone in our efforts to instruc and educate our naval Officers and seamen in the use of the torpedo and submarine mine; nearly every civilized Power has its torpedo school, and the Russians with their exceedingly limited naval responsibilities have not alone torpedo schools, but they educate their naval Officers in the use of the ram. Gunboats protected by fascines have been manœuvred one against the other, and we are sure that such a plan must give much instruction to the Officers who conduct the manœuvres, as well as to those who conn the opposing gun-boats. Russia has also had considerable practice in the use of torpedoes in actual war; they were not, however, very successful with their Baltic mines in 1854 and 1855, which were of a very primitive nature, and of a purely mechanical type. Later, in their Black Sea defences against the Turkish Fleet, they had some successes both with the spar torpedo and the submarine mine; these successes appear to have much stimulated their Officers, who now eagerly pursue the study of torpedo warfare, and appear to indulge in the hope that they may eventually by these means distinguish themselves, and trust that they may baffle the greater naval resources of other countries, that is, should the political necessities of the day again make it necessary for them to defend the coasts of the Baltic and Black Sea.

France, the United States, Italy, Austria, Denmark, Sweden, &c., all have their torpedo schools, and with one or two exceptions have each conducted important and interesting experiments in the use of the submarine mine. In France they have gone so far as to actually destroy a vessel towed at a speed of seven or eight knots by boats armed with the spar torpedo for practice and experiment. They have further put this practice to good use by quite recently destroying two Chinese men-of-war by the same agency. It is believed that the *défense fixé* of their principal seaports has been very successfully organized, and that a complete system of submarine mines are kept ready for submerging by Officers and men well trained to their use.

The United States have never forgotten for a moment the trouble and loss they encountered from the Confederate torpedoes and submarine mines; accordingly they have established a very well-conducted and superior torpedo school at Newport, Rhode Island. There every facility is given for conducting the most scientific electrical experiments, some of which are of so delicate a nature as to be impracticable in the damp atmosphere of a ship. We do not actually advocate a shore-going torpedo school because we mention this, but we think it as well to take note of it, and on the other hand set against it, that our Officers who are taught in a ship will practise in actual war under the same conditions and under the same disadvantages as they in-

herently contended with during their course of torpedo instruction afloat.

It is a significant fact well worthy of attention as regards the high estimation in which the American nation hold the future of torpedo warfare, that while their Navy is kept in a very low condition and is in many ways starved through the low estimates annually voted by Congress, yet that they have taken equal if not greater trouble to instruct their Officers and seamen in this new branch of naval warfare than some other nations who yearly spend enormous sums on the maintenance of their fleets.

We advocate for consideration whether all our engineer Officers should not be instructed in practical electricity, and further that they should have the opportunity of voluntarily becoming trained torpedoists. We also do not think that it is necessary to confine the Warrant Officers torpedoists to gunners alone, we think that a proportion of the younger boatswains might with advantage to the Service be allowed to become torpedo Warrant Officers. In the event of a heavy naval war, the strain on the number of Officers and Warrant Officers specially trained as torpedoists is sure to be very great; we do not think the number at present so qualified is by any means adequate. Our own idea is that in the event of war we ought at least to be able to at once man 300 torpedo-boats. with a large proportion of torpedo-cruizers and torpedo-hunters, this number to be entirely independent of the torpedo-boats carried by our large ships, and the steam pinnaces and cutters of the smaller vessels.

To get the full value out of such a flotilla in time of war, it is necessary that the Officers who man them should be familiar with the inside of the enemy's ports and harbours; a most valuable course of instruction would be to send a number of Officers yearly to visit and privately report on the approaches and defences of the principal foreign seaports, inlets, &c.

We cannot end our remarks on this part of our subject without a word of acknowledgment concerning the great instruction we have personally derived on many professional matters by a constant study of the "Journal of the Royal United Service Institution." Much of our essay is necessarily based on the matter contained in some of the valuable papers that have been read in its theatre, and also from the discussions that followed them. It would be quite unfair on our side if we did not embrace the present opportunity to make this admission, as it also would be if we failed to make some allusion to those great benefits which such an Institution confers on the Naval Service, by collecting and promulgating so much valuable knowledge, the constant dissemination of which must very largely influence the theoretical training of our naval personnel.

Chapter VI.—*Construction and Protection of Matériel.*

Before the era of armour-plated vessels, it was quite possible for a naval architect to assume, and perhaps not unreasonably, that in some newly constructed ship of his own designing he had achieved almost perfection,

Undoubtedly, some of our line-of-battle ships were, in respect to the way in which they responded to all that was required of them, the acme of perfection as ships of war. But how widely different is the case now! the manifold demands of modern naval war make it a *sine quâ non* that every effort that is made by the naval architect towards the attainment of perfection on any one particular point in a modern battle-ship, by so much must he fail in some other special feature, which, if referred to professional opinion, would be pronounced an equal if not a greater necessity.

Let us briefly enumerate and examine a few of these special points which are necessary to the fighting efficiency of the battle-ship of to-day, many of which are the result of the introduction of the ram and the torpedo as naval weapons.

The naval architect of to-day who would design a perfect battle-ship must adopt fine lines and secure a good speed, he must keep the proportion that the length bears to the breadth of his ship well in hand so that he may ensure good manœuvring power, he must take care that his vessel is able to carry a sufficiency of coal and stores, he must protect her machinery and most vital parts with armour of immense thickness, with all this weight he must have engines strong enough to propel her swiftly, and mount at least four very heavy and a fair proportion of lighter guns with the requisite supplies of ammunition and stores for them; his creation must be capable of being used as a powerful ram, she must have a powerful instalment of the Whitehead torpedo, and she must be to a moderate extent secure against the attacks of the ram and of torpedoes; above all she must be seaworthy, have a steady gun platform, and be fairly commodious for both Officers and men.

All these conditions, many of which are in actual contradiction to each other, cannot be reconciled; for instance, what is put on in armour must be taken away from the weight otherwise carried, either from the machinery, guns, or coals; if the ship is built with a bluff bow and a full midship section, she will either be slow or require an equivalent increase in coals and engine power; if she has fine lines to get speed she will not carry her weight, and so on *ad infinitum:* we can only get relief in one way, *i.e.*, by omitting all use of sail power we free the naval architect from one of the many irksome and conflicting conditions by reason of which his designs are restricted and trammelled.

No wonder that we find our naval constructors producing ships so widely different from each other, no wonder that we find them dabbing on strips and patches of armour in one place in some ships, in just the opposite in others; pressed to a great extent by the varying wave of public opinion, what is considered the safety of one vessel is the danger of another. In certain vessels the guns at all costs must be protected, in others it is not the guns and the men who will have to fight them that want protection, but the water-line; while in the very last class of vessels, it is considered best to let the enemies' shot and shell pass if they hit clean through the water-line for two-thirds of the ship's length, protecting with vertical armour only an absurdly

small part of the ship's centre, and placing therein all that is vital, keeping the water that must flow freely in to either end through shot holes or shell chasms from going below by means of a strongly armoured deck. But enough: it is easy for us to quibble, we are fortunately not naval architects; still we write as we do to show the dilemma that exists, as well as to indicate that if aught we should say reflects upon the directors of our naval constructive policy, yet that we are fully sensible of the great and exceeding difficulties of their task.

For a moment only let us suppose that our naval architects are perfect and have reached that happy and impossible state in which they are fully competent to design a perfect battle-ship, and that they have so evenly balanced all the necessary but conflicting conditions, such as speed, protection, &c., in some particular vessel of not unwieldy dimensions, so much so, that for once hostile criticism is disarmed and powerless; but even then they will fail, for given perfection in a vessel of a certain size, we at once leave matters of detail and enter the question of dimensions, when it will be found that a larger vessel can always be built which will be much more powerful; then we may say that the skill of the architect being perfect, the powers of each ship will vary with her actual weight or displacement, we may positively state that increased displacement should give increased power.

This cannot be gainsaid; but as to the consequences of increased size, where is to be the limit? Do not the necessities of modern naval war most positively forbid that we should throw our whole constructive strength into the creation of the biggest possible ships? Each monster ship being, as we shall show, equally liable to fall a victim to the ram or torpedo, it would be a fatal error to build big ships alone. But we do say, and that vigorously, that it would be most imprudent for us as a wealthy maritime nation to allow other nations, who are naturally less maritime than ourselves, to outdo us in the creation of these large ships of unequalled powers: no, we should create ship for ship with them, lamenting the necessity for such large expenditure but fully recognizing the imperative force of it, being fairly content to equal or moderately surpass our rivals for the supremacy of the seas; in the construction of these monster vessels we should still better take care not to limit our efforts to their construction alone, but be sure of having a largely preponderating force of what we might denominate second-class armour-clads, which, while they were less costly, would take a good place in the columns of our future fleets.

We venture to think, not however without considerable diffidence, that our recent shipbuilding policy has not been altogether successful; it is true that in one or two vessels we may have excelled, and for a time have outstripped the other Powers who compete with us, but in the main, and we say it with all humility, the result is not altogether satisfactory.

We do not mean our essay to be in any way a critical attack, far from it, but simply wish to express our own views as a seaman, happy if our thoughts, should they be made prominent by the award of the

referees, can add one atom towards our naval strength in the future; happier still if aught that we say as to the inefficiency of our warships can be promptly and authoritatively denounced as incorrect.

We know that the first application of armour-plating was to keep out the shells, without it our wooden-built ships were, on going into action, nothing but the material for huge bonfires, this was well understood long before the introduction of armour-clads; but the actual necessity of having plates to keep out shells was not practically illustrated and endorsed until Sinope, and again, their value was not tested and approved until still later, during the attack on Kinburn. The result of this action and the impunity with which the hastily-constructed floating batteries of the French under a hailstorm of shot and shell attacked the Russian forts, induced the Emperor Napoleon III to sanction the construction of "La Gloire" in 1859, and we followed quickly with our "Warrior," "Black Prince," &c.; since then the contest between guns and plates has been almost universal and perpetual, and it is likely to continue. Even in the presence of the ram and the torpedo, we feel that it is necessary to discuss the armour and gun question; the former have not yet succeeded in exterminating the latter, for the ram itself, to say nothing of the locomotive torpedo, may be looked upon as the natural outcome of the desire to easily destroy a powerful heavily armed and armoured vessel; it would be folly to suppose (if the locomotive torpedo did not exist) that in the ordinary course of naval war, the well-armoured and well-armed ship would not be able to destroy all unarmoured vessels whom she can equal or surpass in speed; we consider that quick-firing and machine-guns will give a strong impetus to the retention of even a moderate thickness of armour.

The contest between guns and armour which, as we have said, has been perpetual for the last quarter of a century, has as far as the navies of England and France are concerned now assumed a very eventful stage; the ideas of both nations are running, if we may judge by their most recently constructed battle-ships, on the same lines, but on strangely differing principles; both have agreed to increase the strength and thickness of the armour by limiting its application. While we have retained vertical armour on the citadel only, trusting to an armoured deck to give safety to some two-thirds of the length of our new ships, the French have meanwhile still adhered to the armoured belt, very much narrowed in its vertical height, but extending the whole length of the water-line. We find ourselves represented by vessels of the "Inflexible," "Colossus," and "Collingwood" types; and we see the French represented by the "Amiral Duperré," "Baudin," &c. If our system be right, we may be very well satisfied with ourselves; if it be wrong, we are truly in a dangerous predicament; and we are nationally very much in need of some forbearance on the part of a neighbour who does not enjoy a very stable Government, and whose interests at present are liable to clash and conflict with our own in nearly every part of the globe.

Here we feel that it is necessary for us to pause a moment and justify ourselves once again for apparently taking our subject beyond

its proper limits; but we say that if a ship be liable to be (through defective construction or through not being built on sound principles) waterlogged by gun-fire, she must then fall an easy victim to the ram or to the torpedo, and hence by inference fall within the scope of our labours; in any case the matter is one of national importance and cannot well receive too much attention.

The ends of all our latest armour-clads of which, in addition to the "Inflexible," we shall soon have ten, are entirely unprotected as far as vertical armour is concerned; but a stout armoured deck rises from their sides some six feet below their water-line up to or above that level amidships, and sloping down forwards to the point of the ram. This deck is both shot and bomb proof, and very materially contributes to the strength of the ship. While the ends of these ships above the armoured deck have been purposely constructed of thin plating to let almost any description of shot and shell through, all sorts of ingenious plans have been arranged to reduce the influx of water due to such damage; there are many subdivisions over the deck, coffer-dams, stowage of coal, filling in with cork, &c.

This method of construction has its own merits, *provided*—we would emphasize the word provided—the citadel is so thick that it is impenetrable by the guns of an enemy, and also that the guns fired from it are so powerful as to be sure, if they hit, of smashing a large hole in the water-line belt of the enemy; if the "Collingwood" were thus situate as regards the "Amiral Duperré," we might on paper at least safely award her the victory.

But on a close examination a different result appears more than probable: it seems that the "Amiral Duperré" will nearly equal the "Collingwood" in the power of her big guns and surpass her in the matter of small guns, that her big guns will be distributed in four towers instead of two; it is true that they are not so well protected as those of the "Collingwood," but there are four towers instead of two to disable; in the matter of central protection we will allow both ships to be equal, but for two-thirds her length the "Collingwood" must let every shot or shell of the enemy pass in at one side and out at the other, and it is possible, nay, even probable, that large shell may strip off yards of this thin plating at a time, and that any part can be riddled by Hotchkiss bullets.

We acknowledge the "Collingwood" to be a grand ship; her speed and coal supply are excellent, she carries ammunition and stores largely in excess of her rival, and we are convinced that she would make a far better fight than some of her critics are disposed to admit; but if during the first hour of a combat with a ship like the "Amiral Duperré" she were liable, as we believe she is, to have one or both of her ends waterlogged before either her ram or torpedoes have been successfully used, then there is no need to follow the result much farther; if speed or steering power be affected seriously the battle is lost, the ram or the torpedo will quickly complete the destruction that was commenced by the gun. Before quitting this part of our subject we think it is worth contemplating what would be the effect of severe injury to the unprotected stem of the "Collingwood" above the

armoured deck; she already at full speed carries a high bow-wave, what if this wave was poured by reason of the ship's velocity into a chasm at the bow! Where could the water so heaped up and pressed in, escape, what could withstand such hydraulic pressure? We fear the result would be most disastrous.

N.B.—If the compressed cellulose cocoanut-fibre which has recently been tried in France, and which, by swelling rapidly the moment it is wetted closes up any hole made through it most effectually, be found to be a definite success, its employment will add enormously to the strength and fighting powers of our new ships with unarmoured ends.

Enough has been said to show that, in the presence of light quick-firing and machine-guns, it is well to have protection at the water-line; even a narrow vertical steel belt of three, or even two inches, would stop all light and deflect many heavy projectiles.

We do not like barbette towers; in spite of their greater weight we prefer revolving turrets; it has to be acknowledged that the return smoke from heavy breech-loaders will be highly inconvenient in a turret, this is a difficulty that can be got over; either barbette or turret is, however, infinitely preferable to placing a heavy gun in a narrow port with a limited training of only a few degrees; it is quite as bad as putting a light under a bushel. We have heard people say let the ship train the gun: we say on the contrary and most decidedly, let the gun have as much training as possible independently of the ship, and let the ship have the advantage of manœuvring independently of the gun. The Captain of a ship in action will have often quite enough to do to avoid the ram or the torpedo of his enemy, and at the same time seek to use his own similar weapons should a weak turn on the part of his antagonist give him the chance, without his being bothered and tortured with the additional effort to keep his guns bearing. The gunnery advantage in a single action will lie with that ship whose guns are so well arranged that a part of them will always bear on the foe. Let a Captain if he so wills it train those of his guns that have a very limited training on a given bearing and fire them electrically as they are brought to bear; but if he has to fidget so as to constantly nurse a broadside of guns to keep them bearing on the enemy, he is as likely as not to get his ship rammed or struck by a Whitehead torpedo.

Although stability at large angles of heel is now unnecessary to render our battle-ships safe to carry sail, yet it is still a necessary quantity among those stubborn and conflicting forces which the naval architect of our day has to reconcile. The ram and the torpedo make it an absolute condition of safety in action that a ship should have a fair reserve of stability and a large surplus of buoyancy.

To obtain this, the weights must be kept fairly low in the vessel, and the freeboard must be made at least moderately high.

When we were alone confronted with the undiluted question of guns *v.* plates, a low freeboard was such an evident and palpable advantage from a fighting point of view that we may not unreasonably assume that its attainment mainly led to the loss of the unfortunate

"Captain" and her gallant Officers and crew; her sad catastrophe, followed as it was by the abolition of heavily-rigged battle-ships, and the construction of powerful sailless turret-ships of low freeboard, has in a very short interval taken us from the Scylla of capsizing under sail to the Charybdis of turning turtle in action from injuries sustained by the ram, the torpedo, or the submarine mines of an enemy.

There can be little doubt existing in the minds of those of us who have applied ourselves to the question, that in the future the two former weapons must take the most prominent places in large naval battles, and the damages and injuries they will inflict will never be above but always below the water; the battering fire from guns, if we except those chance shots which happen to strike at or below the water-line, will seldom or ever affect either the flotation or the stability of an armoured vessel, but on the contrary every blow of the ram or shock from the exploded torpedo must in every case at once directly influence and affect these vital qualities.

Indeed, we may say that in any vessel not well endowed with surplus buoyancy, or which has not a respectable stability, the very safeguards on which she relies to save her from rapid sinking if struck by ram or torpedo contain in themselves a formidable element of danger. In these days of central divisions, fore and aft bulkheads, huge wing passages, and spacious double bottoms, what is to become of that vessel that has had several hundred tons of water run in on one side of her, and whose low freeboard gives her a vanishing stability at a small angle of heel? The steady platform that it may previously have afforded can be no compensation in such a case.

It is self-evident that the ram and the locomotive torpedo demand that a fair measure of stability be given to all war-ships, and that the low freeboard be abolished.

The spectacle that would be exhibited by many of the large war-vessels of the present day after the first hour of a closely-contested fleet action would be, but for its dreadful sublimity, absolutely ridiculous. In the older days after a hard-fought fight the battle-ships of the combatant fleets floated proudly upright to the last; they might be indeed dismasted and helpless, or on fire, but even then they floated grandly until their magazine exploded; or they might settle slowly and sullenly to the bottom through their pumps being unable to clear the ship of water, but they were fairly stable until their very last moments had come. But now let us picture to ourselves the spectacle which the survivors of a fleet action would show us; some ships will have bodily turned turtle, and gone to the bottom like a pig of ballast; we shall not of course see them, but we shall see others lying over bodily on one side in imminent danger of doing the same thing; some few will have their bows deeply immersed in the waves with their propellers wildly revolving in mid-air. Others in a better plight may have their rams pointing to the skies, or be in the condition of a half-tide rock with their deck freely swept by every wave. On such an occasion the victors will hardly be able to comfort themselves with an air of triumph; the defeated would require nothing to add to their dejected appearance.

It is evident that the efficient arrangement and distribution of guns bears strongly for or against a successful attack by the ram or the torpedo. The larger arc and field of training that the skill of the naval architect can give not only to the individual but the whole of the guns of any ship, so much the more efficient must she be, not alone on this particular point, when she is called on to match her guns against the guns of an opponent, but in the free and unrestricted use of the two weapons which it is more especially our duty to discuss in this essay.

In the same sense we may here appropriately argue that the Whitehead torpedo already demands that when it is installed in any ship the points from which it is discharged shall not be limited to one or two directions; right astern and bow and quarter discharges are almost, if not quite, as necessary as a right ahead or abeam instalment.

We have personally long been of the opinion that the small craft of the French Navy were superior to our own on the first-mentioned point, most of their guns being mounted so as to have a large training field; their chief defect being that the gun was too much exposed. This will tell greatly against them now that machine-gun fire is of so much importance. The corvettes and larger gunboats of the French have been greatly superior to ours in speed; though carrying a lighter armament than the corresponding vessels of our Service, also having a lighter rig, they were much better suited for look-out service and cruizing work than our craft, who would, should occasion have required it, stood no chance of catching them. We deplore the miserable craft that we call sloops, they can neither sail nor steam, they do to show the flag to some disadvantage in distant ports, and they carry a fair armament; but their miserably slow speed renders them useless for war, when they would have to stow themselves away in some neutral port and transfer their crews to a fast cruizer or armed merchant steamer.

We have had of late plenty of opportunity for observation, and we say positively that our present sloops and gun-vessels are totally unable to overtake the most ordinary merchant steamer if she chooses to make them chase her head to wind.

Our gunboats and gun-vessels are nearly in the same category, but they may be of some service up rivers, or in narrow waters, and the newer ones steam rather better than the old ones, especially better than the old double-screw makeshifts, which were constructed mainly with the view to utilize old engines.

To construct sloops and gunboats that will be of some use in a modern naval war, we must abandon the absurd amount of beam that we give in proportion to length, and give up the idea of making a compromise between steam and sails; we do not want a vessel to sail well in time of war, but she must steam well or she is useless, more especially so for ramming or torpedo work.

There are so few frigates that it is hardly worth while to notice their existence in our essay; fast sloops and belted cruizers will take their place in the naval wars of the future, those we have should be

fitted to act as rams, and be well fitted to discharge Whitehead torpedoes. It would be the extreme of folly to expect an unarmoured ship to attack an armoured ship by day; but at night the inequality due to protective plating would be less, and the unarmoured ship might successfully use, by reason of superior speed, either the ram or the torpedo.

The construction of torpedo-hunters and scouts must form a very important item in all naval estimates of the future, fast vessels of light draught, fair seagoing qualities, and armed with quick-firing guns will not alone prove of the greatest value in destroying the torpedo-boats of an enemy; but they will also from their ability to accompany a fleet, and their armament of Whitehead torpedoes, prove themselves valuable allies to armour-clads, even in line-of-battle. Such vessels should have a speed of 18 knots, and a tonnage displacement of from 400 to 600 tons; they will be expensive to construct, as the materials of which they are built must be of the best mild steel, as light and strong as it can be got, and the engines must for their weight develop a very high horse-power. No armour or plating will be possible except perhaps a shield for each quick-firing gun, a curved deck over the boilers, and a light protection for the Captain and for the steering wheel.

We look upon the much-abused "Polyphemus" as a decided success; she would no doubt be much improved if some of her most venturesome peculiarities could be left out, such as the dropping weight, &c., but with all this we are sure that she would be of great service in a fleet battle, and she is eminently well fitted to run amuck at night through an enemy's squadron; she would also be an immense assistance to any fleet in helping to beat off a torpedo-boat attack. We do not by any means think that she will be the last of her class.

The half dozen torpedo-cruizers now under construction for the Royal Navy have been begun not a day too soon. They promise to take a valuable place in our war fleet, and their absence, if we had to make war without them, would be much felt. We think they are too large and costly to be employed in watching ports containing ordinary first class torpedo-boats, and their draught of water will not exempt them from occasionally falling victims to night attacks from Whiteheads, but by day in any seaway their high speed will make them the terror of most torpedo-boats,[1] and they will be a great safeguard to a blockading or cruizing fleet.

We look to torpedo-boats for most of the hard work and fighting in the next naval war; for night attacks, night defence, for all the old cutting-out work, torpedo-boats will be employed. Let us note the avidity with which certain foreign Powers have seized on the idea of employing them, rejoicing in the thought that torpedo warfare may level the power of all maritime nations. Some foreign writers have gone so far as to openly exult in the thought that they may so nullify our naval supremacy. The most important of the European nations already possess more torpedo-boats than we do, and compared with

[1] We think they are hardly fast enough to catch torpedo-boats in smooth water.

their requirements they certainly seem to have stolen a march upon us, both in the number of the boats and the pains they take by attaching them to their fleets, and otherwise exercising them, to ensure to ensure their efficiency.

French torpedo-boats have recently in actual war destroyed with the spar torpedo two Chinese men-of-war, and just before the conclusion of their peace with China several first class boats were sent out to their China squadron.

The Italian squadron which was sent down the Red Sea this spring was accompanied by six thoroughly well-found and equipped torpedo-boats of the first class.

It is the opinion of the French that they will peculiarly benefit by the construction and employment of torpedo-boats; their geographical position allows them by virtue of their railways and canals to concentrate at will their torpedo-boat force, either in the Channel, Bay of Biscay, or Mediterranean, and their newly-acquired territory of Tunis, to say nothing of Algeria, abounds in small harbours very suitable to shelter torpedo-vessels; these ports command nearly the whole of our trade route between Malta and Gibraltar.

It has been very recently proposed by a French writer who is well versed in naval matters to supplement the *défense fixé* of their five principal naval war ports or arsenals by distributing 75 torpedo-boats amongst them as follows as a *défense mobile*:—At Cherbourg, 20; Toulon, 20; Brest, 15; Rochefort and L'Orient, 10 each. All these boats are, as we have said, capable of concentration at one port, but our writer is not satisfied with such a force. He further argues that no time should be lost in providing 100 torpedo-boats for the defence of colonial ports, 100 for the formation of an active torpedo cruizing fleet in the Channel, Mediterranean, &c.

If France is willing to construct such vast numbers of these boats, it is no time for us to linger over their rapid construction. Fortunately for us, private enterprise has placed us in a position to rapidly obtain from well-established firms a number of torpedo-boats of the best quality and construction, without putting any strain whatever on our public dockyards.

The construction of these fragile but swift craft requires workmen of the greatest skill and ability, not only for their hulls but for their machinery. We say again that it is fortunate for us a nation that we have at least two reliable firms to construct these vessels for us; but good as the Thornycroft and Yarrow boats are, they are run close if not beaten by Messrs. Normand in France, and we believe that the Germans have also been successful in constructing fast boats for themselves.

It will probably take from nine months to a year to complete the construction of a first class torpedo-boat, from the date of the order to the trial trip, so we may be sure that it is unwise to leave the order for their construction until the day when we are suddenly involved in a maritime war; it is true that this is only one-third of the time required to construct an armour-clad vessel, and that to the amount of this difference of time our country is clearly the gainer, for with our

resources we could launch ten boats to one launched by other countries in the same time; but even three months might in these days of rapid but costly wars be fatal to our maritime supremacy, that is if we were left for that space of time unprepared and without a sufficiency of torpedo-boats.

Steamers of the "Hecla" class fitted to carry torpedoes, torpedo-gear, and a large proportion of submarine mines, with a fair proportion of torpedo-boats, are most necessary. They should not only accompany a squadron, but be detached to harass the ports and harbours of a blockading enemy; but we do not think it is necessary that these vessels should be constructed in the Royal Dockyards; efficient merchant steamers can be purchased very suitable for such work. These should be bought, then altered and otherwise fitted for the work they will have to do. They must primarily be vessels of good speed, for we may be sure that an active enemy would leave no stone unturned to destroy vessels of this class with their valuable cargo of second class torpedo-boats and torpedo stores. We think that our Navy should at least possess three vessels, improved "Hecla's," no matter whether bought or constructed.

It has been well proved in our large armour-clad turret-ships that mast and sail power can be advantageously dispensed with; but although masts are not necessary to spread sail on, they are by no means useless; on the contrary, one or two stout military masts on which to mount machine-guns are actually demanded. Guns so placed will be most useful in action to keep down the machine-gun fire of an enemy, and to pick off any people who may be exposed on his decks or hull; military masts are besides useful in obtaining the range, and from their tops being above the smoke they will often be the only place whence a view of the enemy can be got; also we must not forget the importance to an armour-clad vessel of commanding a large horizon; when we reflect that they are exposed to the attack of boats that can travel at a speed of 20 knots, we cannot help admitting that a wide range of vision and a sharp look-out from aloft are things not to be despised. Hence it seems that every large ship should be constructed to at least carry one military mast with a long topmast, fitted with a crow's nest for the look-out man. We do not see any good reason why these military masts should not have two tops or platforms fitted to them, the upper one in the usual place and the other beneath it, just high enough to be clear of the smoke of the funnel; the situation would be commanding, and in our barbette and turret-ships it is not easy to find the requisite places to mount all the machine and quick-firing guns that are needful.

Any fleet on detached service would require to be accompanied by a factory steamer, capable of rapidly repairing torpedo-boats, and with appliances on board for the speedy repair of heavy machinery. The services of such a vessel would be in these days constantly in requisition; we doubt whether it is wise to postpone the construction or fitment of such vessels until we are involved in a maritime war.

Special hospital ships are also a necessity, but these can fortunately

be utilized very rapidly from amongst the largest of our noble merchant steamers.

A factory steamer, wherein large repairs to machinery and plates could be carried out, must follow closely on the heels of every considerable assemblage of war-vessels; such a vessel should be capable of hoisting in and repairing a first class torpedo-boat.

CHAPTER VII.—*Attack and Defence of Ships: Fleet Attacks.*

The conditions now existing under which either ships singly, or combined as squadrons or fleets, will attack each other, or defend themselves from attack as opportunity or occasion may require, are so vastly different from all previous experience as recorded in our naval history, that it requires the exercise of some courage to prophesy what the naval tactics of the future will be; nevertheless the great diversity of opinion which now exists on most naval matters renders it at least easy to predict, however rash our assumption may be, that we are yet sure to witness some very startling surprises, whensoever the next war between two really strong naval Powers may occur. Meantime we would not ignore the fact, that the wars which have occurred during the last quarter of a century have given us some very valuable data, or attempt to deny that from their issues some useful lessons have not been learned; but none of these wars have been a stern contest for the supremacy of the seas, such as our forefathers fought so well, and such as we ourselves may have to fight at no very distant date. In most of the recent wars one of the contending nations has usually commanded a preponderating naval force, and in others, we say it without levity, it has been merely playing at naval war; the stern courage, the equality of forces, the intense reality of our old sea fights, of Trafalgar, of the Nile, of Lord Howe's victory, have all been wanting. Enough, however, has been done to let us take a fair measure of the employment of shell fire, of protective armour, and of the destructive effects of the ram, the torpedo, and the submarine mine, as well as the extreme alteration of naval tactics that will be *nolens volens* forced upon us in the future.

As we have already said, the omnipotence of the battle-ship has departed, her immense powers of fight are liable to be often nullified or rendered useless in the presence of (as far as size and cost is concerned) well nigh contemptible antagonists; it is indeed by no means certain whether in a few years' time these monster battle-ships, as we now know them, will even be in existence; but it is sufficient for our present purpose that they do exist, and that in spite of a strong foreboding to the contrary we do not dare to say that their presence could be dispensed with, or that we could find any sufficient substitute for them, wherewith to awe our enemies and protect our shores and commerce; indeed we go further, and do not hesitate to repeat that as long as other nations persist in constructing these costly battle-ships, so must we, regardless of cost, continue to do so; with our present limited experience, it would be the rankest gambling if we discontinued their construction. It appears to us that as matters now

stand, the armoured battle-ships must be regarded as the nucleus on which to form a hybrid fleet of swift rams and swifter torpedo-vessels. And we venture to assert, to the full extent of the force of which our feeble pen is capable, that without being strongly supplemented by such craft, any armoured fleet, however well found it was in itself, must in the presence of an active enemy have nothing but a hard time of it. In a few words the long and short of the matter is, that it is necessary to have a fleet of battle-ships to face the battle-ships of the enemy; such ships, when naval supremacy has been ensured, to be used to bombard and attack towns and seaports; but that in the first instance it would be a foolhardy proceeding to expose such ships wantonly and unsupplemented to the attack of smaller and swifter vessels which were fitted as rams or torpedo-vessels.

The attacks of swift torpedo-vessels may be made so insidiously, either by day or by night, or during thick weather, that they can only be successfully combated or baffled by the employment of similar or special vessels purposely armed to destroy them. Thus it may be accepted as a positive axiom that it is and will be necessary to destroy torpedo-vessels with vessels designed to destroy torpedo-vessels, to fight small and swift rams with small and swift rams, to seek and destroy the swift cruizer with swift cruizer, and that all these vessels, while scouting or skirmishing around and in the vicinity of armoured fleets, will have constant encounters with each other; and finally, on two armoured fleets deciding to submit their destiny to the fate of an action, that then, in the dire smoke and confusion that will follow, leading up as it will to the awfully mad *mêlée* which must inevitably result before the battle is lost or won, then we say that at this supreme moment these small and swift vessels are destined to take no mean part in the victory or defeat of the day.

The fleet which can make use of a preponderating force of such craft should, other things being equal, have the advantage over its adversary.

Among these other things upon whose equality we have somewhat lightly dwelt, high speed, as we shall hope to show further on, will be an immense advantage, indeed the seagoing attack of torpedo-vessels hinges entirely on high speed.

In the presence of an enemy, the successful manœuvres of a fleet will depend on a high speed; two or three very slow ships are better out of it, they will only encumber the rapid manœuvres of the whole.

The collective speed of a squadron or fleet before going into action must be limited to the speed of its slowest ship. In keeping correct station it is necessary that all ships except the leader should have a small reserve of speed in hand. Few evolutions can be carried out without reducing the progressive speed of a fleet some three knots below the speed of its slowest ships. The presence of one or two slow ships in a fleet, whose services were actually necessary to bring its numerical strength up to the level of that of the enemy, would be an unmitigated nuisance to the Admiral in command. It is most probable that the divisions of a fleet, and their subdivisions, will each

have their ships selected so as to ensure, as much as possible, an equality of speed; great advantages can thus be derived in the way of maintaining the speed of the fleet, by in all evolutions assigning the most work to the fastest division or subdivisions; we shall say more on this head in a future chapter.

The very complete transition of sail power into steam power, at which we have now arrived, has eliminated all the uncertainties which in the old days were due to wind and weather; the movements of the larger vessels of two hostile fleets are rendered with small exception as certain and absolutely controllable as the movements of two squadrons of hostile cavalry, more so indeed, for on the open sea there are no fences, walls, obstacles, or rough ground to embarrass or confuse one or other of the combatants.

Let us a little further on endeavour in imagination to depict a fleet battle of the future, and in a few words only demonstrate the tactical value of the fighting quantities that can be contained in each of the units that will compose a modern fleet.

In the first place we assert that it will be most important that a fleet should not be allowed to blunder unexpectedly into sight of the enemy's fleet; a fleet surprised is taken at a most decided disadvantage; for instance, we will suppose that for the sake of husbanding fuel the fires are low; on sighting the enemy on the horizon, steam for full speed will be the first order given; again, supposing the weather to be fine, torpedo-boats must be got out or lowered, and the ships cleared for action: what time will be given to do all this? Two vessels proceeding at 10 knots in opposite directions meet in twenty minutes from the horizon; in any case from twenty to forty minutes will be the longest time allowed for preparation. Is the unready fleet to turn and by a temporary retreat evade the rapid approach of the other, and thus gain time? This would appear to be the only plan. Yet, would it not look suspiciously like fear, and a direct invitation to the enemy to come on boldly to the attack? There can only be one answer to this.

Certainly then it will be of the highest importance to prevent a surprise, even on the high seas; but for a fleet to be suprised at anchor, simply means a repetition of Sinope; the ram and the torpedo, however, will do the work of the Russian shells on the occasion of that massacre. We do not suppose for a moment that a fleet of ours will ever be surprised in this way, but it is necessary for our argument to show the danger of it.

To prevent a surprise it will be necessary both at sea and at anchor to have the approaches to the fleet guarded by fast look-out ships, or vedettes, extended some 10 or 12 miles, keeping touch of each other, and being extremely vigilant and jealous of all approaching vessels, stopping and boarding all strangers, and passing on by signal any information that may be obtained. A strong force of these vessels should precede the course of a fleet, and a lesser number should extend on both beams and astern of it: could armoured vessels do this work for themselves? No, most certainly not; goodness knows they are short-winded enough as it is, their bunkers would soon be

empty if they were thus employed; there are indeed no frigates and few corvettes in our Service that are equal to it; the only vessels that we know which could do it well would be our fast armed merchant steamers; their high speed, great coal capacity, especially so if coal were stowed in place of cargo, render these vessels of unequalled endurance as scouts or cruizers; there should be no fighting for them here, speedy information is all that is required. Our new torpedo-cruizers, such as the "Scout" and "Mohawk," promise to be well fitted for this work; the "Mercury" has since proved her ability.

In very fine weather, or in narrow waters, torpedo-boats of the larger class could be utilized as vedettes, but they are very low in the water, and can see no distance, besides being short-winded if hard pressed. Their more proper function would be to lie close to the fleet, under easy steam, and in constant readiness for work. In our opinion, wrong though it may be, our present first class torpedo-boats are incapable of being constantly kept with a fleet,[1] they may do so for a short run, in and out of a port, but otherwise the wear and tear on not alone the boats, but on their Officers and men, would be too great. They are, however, well fitted indeed for issuing from a harbour for a night attack; for sending inshore of the fleet to reconnoitre; or to support their fleet in an action during fine weather, but as regards a really seagoing independent existence they are quite incapable.

A much larger and more powerful class of vessel is needed, and will have to be built by all those nations who aspire to the possession of an efficient navy.

The naval Power which can first create a large force of fairly seagoing torpedo-vessels, of high speed, which are capable let us say of keeping the sea for a week independently and on their own resources, will have largely augmented its naval strength.

Having hastily discussed their probable composition and organization, we will now, for the sake of illustrating our arguments, consider that we have two hostile fleets approaching each other, and that they are each individually intent on seeking in their coming encounter either absolute victory or defeat; they have each been duly apprised of their proximity to each other by the rapid signalling and falling back of their respective scouts; they are prepared in every way; the men are at quarters; the roaring of the escaping steam from the boilers tells us that steam is ready for full speed; they are nearing each other at a moderate speed; accurate station is preserved, the ships are well up to each other in close order; but in what formation? We dare not say! it must be left to the master mind of some future Nelson to select that formation which shall oppose the rams of his leading ships, well supported, to the rams of the weakest or least supported part of the ranks of his enemy; if three rams can be opposed to two rams the advantage is obvious. Half an hour has elapsed, the scouts have all fallen back, the torpedo-boats are assembled together or told off to close and support their respective

[1] We had written this before the formation of Sir Geoffrey Hornby's fleet, and his report seems to confirm our views.

ships; each fleet having with alacrity obeyed the signals of its chief has rapidly resolved itself into his chosen formation. The fleets having increased speed are swiftly closing each other, there is little time now left for those in command to feel either anxiety or suspense; if both fleets are equally courageous they must in a few moments meet, bow to bow; the charge will be furious; the higher the speed, the better for that side which obtains it; the ships must rush at, into, or failing this, pass each other.

This charge will have been fatal to some of the weakest bowed ships, or to those which have not undauntedly presented the point of their ram to the opposing ram of an enemy; by preconcerted arrangement a rapid wheel of the survivors or those which are not crippled takes place; the charge will be renewed; guns hitherto silent will be rapidly and incessantly discharged, the dire disorder and confusion will be awful, there will be a mad medley of ships and boats, a roaring of escaping steam; the loud discharges and smoke of the heavy guns mingling with the horrid and perpetual rattling of the quick-firing and machine-guns, interspersed with the dull explosion of the torpedo and its consequent upheaval of water; such a scene once witnessed would be for ever indelibly impressed upon the memory of a beholder. Amidst such disorder the opportunity for the swift ram and torpedo-vessel exists; here the weak may in a moment conquer or demolish the strong, a torpedo-boat handled with skill and courage may fatally injure the most goodly vessel; it is needless to follow such a battle to the end, but it will be evident, as the noise and confusion subside, to which side victory is inclining; there will be left the sad spectacle of many a magnificent vessel disabled, water-logged, or sinking.

It is possible that the remains of each fleet will re-form and withdraw, in which case the first to receive a reinforcement of armour-clads, even if these should be of an antiquated type, will be able to renew the action and ensure a victory.

The question as to whether gun-fire should be opened or withheld when the first furious charge is taking place, is a momentous one. We think that when one fleet is rushing to the attack of another, there should be absolute silence, the eyes of every Captain should be concentrated on his leaders, firing might be, perhaps, permitted from machine-guns in the tops, but most decidedly not from big guns until immediately before the ships have closed and are going to strike each other, or point blank on passing, but no shot should be fired that was not absolutely certain of finding its billet in an enemy's vessel: after passing there should be no firing; it will be better to wheel and re-form with quietness and precision. After a charge such as we have depicted, contrast the advantages that would accrue to the fleet that had first wheeled and re-formed itself into a compact formation, over another fleet which, by continuing a wild fire, had its vessels still in disorder. With which should success rest on a repetition of the charge? Our views, as now expressed, would, however, be much modified by the introduction of that really great desideratum, a smokeless powder.

We do not mean to lay it down as a positive rule that such sharp and decisive attacks as the one we have endeavoured to describe will always obtain; it is quite an equal probability that if one of two hostile fleets knows that it has the heels of the other, it may be at first successfully manœuvred so as to limit the battle to an artillery duel; but if close action be resolutely pushed and sought for by the slower fleet, the battle must assume the appearance of a retreat and a pursuit. Here firing will be constant and necessary, then we shall find the fastest ships of the pursuing fleet pushed on to the attack of the rear of the enemy; they will be accompanied by torpedo-boats, who will take shelter behind them, when any of the ships of the retreating fleet are brought to bay, and are in danger of being destroyed, a general action as before will be then imminent.

It is not altogether improbable that two fleets of about equal composition and strength may elect to simultaneously advance their torpedo flotillas, and these may have a separate action of their own, apart from the combat of the hostile armour-clads.

Of one thing we may be definitely assured, it is that we shall never have another repetition of such fights as those so well fought in the Bays of Aboukir and Trafalgar; the fleets of our future enemies will never now be found at anchor, or lying to at sea, to await our attack. A fleet that is desirous of avoiding the attack of another fleet must seek the refuge of some strongly fortified port, or a harbour with a narrow entrance that can be rapidly defended by submarine mines,—this change of tactics has been accomplished by steam, by the ram, and by the locomotive torpedo.

We may, however, justly surmise that the fleet battles of the future will be fought out on or near the old historical battle waters of Europe, the lack of coaling stations and distant dock accommodation will forbid the fleets of foreign Powers from assembling in distant parts of the globe for many years to come.

It is most difficult and almost rash on our part to hazard an estimate of the part that locomotive torpedoes will play in future fleet actions; we have said that their general employment must, at first, be most carefully restrained, but when we know how great their powers of destruction are, we must all feel how great will be the temptation to use them, and it would seem almost unwise to let any opportunity for their successful use slip by, not knowing when it may again occur. All experiments go to prove that it is useless to fire locomotive torpedoes at ships that are end-on, the target thus offered is small, and the least slow or swerve of the enemy avoids the torpedo; the wash of the screw astern, or a large bow wave ahead would also deflect these underwater missiles. But it has been clearly proved by experimental practice that when a fair shot at a passing vessel which is exposing her flank at any distance inside 300 yards is obtained, every torpedo should strike her bottom, provided at least that her speed were correctly estimated to a margin of a couple of knots.

On this basis we form an opinion that on the opening ramming encounter of two hostile fleets taking place, the use of locomotive

torpedoes will be withheld, or they will be only fired at the discretion of some very responsible Officer, possibly the Captain alone. Two ships passing each other at a speed of 10 knots would give a good chance to an expert operator with the Whitehead torpedo, more so if the two ships were abreast of each other and steaming in the same direction, or equally so if one ship shall expose her flank to the bow torpedo discharge of her adversary; a locomotive torpedo then expertly fired ought seldom to fail.

Much of course will depend on the speed of the torpedo, the old 10-knot Whitehead would be useless for such warfare, and a 30-knot weapon, if it can be got, will give double the chance of a hit that the present 20-knot Whitehead affords.

Locomotive torpedoes make it a hazardous manœuvre to pass under a ship's stern after failing to ram her; here a grand chance is offered to the stern torpedo of the rammee; aimed at the bow of the would-be rammer, as it passed under the stern, it could hardly fail to hit a mark which would extend 300 feet in length.

We do not think that such opportunities as this will often be offered in a single-ship action; for in her wise endeavours to avoid the ram of an opponent, no ship will willingly expose her flank to its attack, hence it is unlikely that one ship will pass under the stern of her enemy at right angles to her course; but the ever-varying contingencies of a fleet action are quite another thing, and such opportunities will then be sure to occur.

CHAPTER VIII.—*Attack and Defence of Ships; Fleet Manœuvres.*

It is the ram, and the ram only, that has revolutionized modern naval tactics, although their basis still remains the same, viz., to oppose at all times a superior force to some part of the enemy's formation; to do this, as far as the improvements in ordnance are concerned, we might well follow the simple tactics of our forefathers; and, again, as far as locomotive torpedoes are concerned, the tactics that were governed by the gun would be equally applicable to their advantageous employment. But the ram is a fixed weapon, it is attached to and can be used solely from one portion of the vessel, in its presence a long line of ships, such, for instance, as the well-known line of battle of our predecessors, becomes the weakest of all formations; we distinctly assert (unless the fleet were very large) that within sight of an enemy's fleet, there should never be more than four ships in a column, and that on such occasions the whole position and assignment of the ships that compose a fleet should be rendered as compact as possible.

It will be sufficient for us to cursorily glance at the annexed diagrams to at once detect the great weakness of an extended line in so far as the ram is concerned, and we say that in the commencement of fleet actions the gun and the locomotive torpedo must be subordinated to the ram; to successfully ram should be the first object; to destroy with the locomotive torpedo and gun the secondary purpose.

In our Diagrams, Figs. IV and V (Plate XI), Fleet A has twelve ships formed in single column line ahead; Fleet B has the same number of ships formed in three columns in line ahead; the ships in each column are two cables distant from each other; we suppose the columns of the Fleet B to be six cables apart.

We have depicted the look-out vessels of each fleet as having fallen back, and then formed themselves in columns; the torpedo flotillas have also been shown each closed up to the support of its own fleet; we here cease for the present further mention of these vessels for the sake of simplifying our argument. It is by no means certain, however, that it would not be very excellent strategy to precede an attack with the ram by a torpedo-boat attack, the confusion which such an attack would create should admirably serve the designs of the rams; or torpedo-vessels may equally with advantage be individually attached to the vessels of each fleet, taking shelter under their large consorts until they were close to the enemy; meantime following the movements of their sheltering ship as closely as the pilot-fish follows the shark. But for the present, as we have said before, we omit much mention of them, for in fleet manœuvres ships must in no way be impeded by their satellites; it will always be the principal duty of the latter until actively engaged with the enemy to avoid hampering the rapid movements of their fleet, who will as far as all manœuvres are concerned ignore their presence. If they get in the way, or get even run over, it must be their own fault.

Fleet A is in the simplest of all formations, each ship has only to follow in the wake of her leader and to preserve distance from her alone.

Fleet B is also in an almost equally simple formation, but the leaders of its columns have also to preserve their bearing and distance from each other, which has to be done by angle and bearing, there being no wake of a ship ahead for them to follow; in this formation, no ship should be more than fourteen cables from another; this fleet is in one of the best possible dispositions for signalling the leaders of columns; repetition of the Admiral's signals being clearly discernible to all the ships.

Fleet A has the advantage of having the whole of its broadside guns clear and free to open fire, and if Fleet B were content to answer gun-fire by gun-fire alone, we might rule that Fleet A had the strategic advantage to this extent.

But to those who know the powers of the ram, it will be evident that this would be the last thing the chief of Fleet B would wish to do, and also that he has every reason to be well satisfied with the compactness of his formation.

We say that, favourably placed as he is, he would at once alter the course of his fleet simultaneously eight points to port, the ships will then be in column in line abreast, heading for Fleet A. What tactics are now open to the leader of Fleet A? We see that if he steamed ahead with unaltered course his rear ships would be cut off by Fleet B; if he turns also to port it will become a retreat and a pursuit; the last and possibly the wisest plan is to turn and face Fleet B (see

Diagram, Fig, V), but even then in the charge that will rapidly follow, his line must be broken and cut in two; the leading division of Fleet B, supported as it is by its eight following ships, can at most be opposed by six of Fleet A's line; the centre and sternmost divisions of B in their turn being first opposed to ships already disordered and broken by the attack of their leading division should have a fair prospect of ramming them.

Presuming that the rear division of B is twelve cables astern of its leading division, and that both fleets are approaching each other at 10 knots speed, there will only be an interval of four minutes from the time that the leading division breaks the enemy's line until the rear division encounters what remains of it.

After the charge, Fleet B should have the best chance of quickly re-forming to renew it, only on this occasion its former rear division should head the attack. It is our deliberate opinion, as we have said more than once in this essay, that the first thing to do after breaking through the ranks of an enemy is to rapidly re-form and head for him again; this should be thoroughly understood and inculcated before going into action. The ships of a fleet when scattered or disordered must go down one by one if vigorously attacked by the rams of an enemy who was still formed in a compact phalanx.

But it is open to the Commander-in-Chief of Fleet A to adopt another plan to meet the threatened attack, though its adoption will involve the total sacrifice of his formation, and he must therefore positively abandon all further idea of solidarity; he can, on discerning B's plan of attack, signal his ships to use their best speed, and acting independently of him and of each other (and as shown by the dotted lines of Diagram, Fig. V), to close and do their best to ram the enemy; here his rear ships might, on wheeling, have a fair chance at the broadsides of Fleet B's port wing and rear ships; but the great confusion into which Fleet A will unavoidably fall, from all its vessels closing each other on different courses, must, even if the efforts of certain ships to ram their enemy be successful, yet be fatal to their further success, *i.e.*, when the remnant of Fleet B has wheeled and renewed its attack on the disordered remnant of Fleet A.

We think we have sufficiently demonstrated the inutility and unmanageableness of our old and once famous line of battle, at least when it has to confront and receive the attack of a more compact formation.

The group system has many advocates, and its use undoubtedly confers many advantages; its principal drawback, however, being the difficulty of accurately preserving a formation which is naturally somewhat intricate and which cannot be accurately preserved by eye and judgment alone; a few rapid alterations of course, the ships turning together, leaves any form of groups in apparent disorder, even though the original bearings and distance have been most accurately preserved. We do not believe in the face of our enemy's fleet or squadron that any formation which requires frequent sextant observation and more frequent compass bearings, calculations, &c., can be well preserved; we hold that the Captain's eye alone should be the instru-

ment to keep his ship in station under such circumstances. This can be done with precision when a fleet is formed in columns in line ahead or line abreast; here those who have had any considerable experience in fleet tactics can, by their eye alone, with a touch of the helm, or by the decrease or increase of a revolution or two of the propeller, keep their ship in perfect station. A statement that the more simple the formation, the easier it is preserved by the fleet, will not brook contradiction. Diagram, Fig. VI, contrasts the strategic positions of two fleets, the one formed in scalene groups of threes in line ahead, and the other in columns of divisions line ahead; Diagram, Fig. VII, represents scalene groups in line abreast, and columns of divisions in line abreast, and is the necessary result of both fleets, as shown in Diagram, Fig. VI, turning towards each other. Here Fleet A appears to be certainly better placed to meet a ramming attack than if formed as in Diagram, Fig. IV; here its ships will be better able to support one another; but on the turn for a second charge as before we still think that Fleet B will have the best of the encounter. It has already opposed the rams of twelve ships to the rams of nine, for we hold the right of Fleet A to be out of the first charge; from opposing three rams to two, Fleet B should have at least disabled two or three ships of Fleet A, and if on the return charge Fleet A has not got into a more compact formation, Fleet B may again have the same opportunity. It will be always futile to pit the ram of one ship against the rams of two; the advantage Nelson gained at Trafalgar by making each of his leading ships engage two of the enemy, will not hold good with the ram. In the matter of Whitehead torpedoes it might still do so, but we much doubt the advantage of using these weapons from big ships, especially during the first onslaught of a fleet action, indiscriminate damage to friend as well as foe might result from so doing.

We shall now add a few more diagrams to represent other formations in which hostile fleets may oppose each other, but as we have said in another place it is at present utterly impossible to predict in what formation or by what strategy some future Nelson may overcome his foes, still we may be assured that it was only by means of long practice and constant study of fleet work, in addition to his innate genius as a Naval Commander, that our great hero gained his ever-glorious victories, in which, from the first sighting of the enemy's fleet, success was never doubtful.

Diagram, Fig. VIII, shows two fleets formed respectively in two columns of scalene groups of threes, and in three columns in line abreast.

Diagram, Fig. IX, exhibits the best formation for a retreat, viz., two bow lines; a retreat and pursuit must at first be only an artillery duel, and may perhaps continue to be so, that is if the ships of the pursuing fleet are of only equal or may be collectively inferior speed to the ships of the retreating fleet, but as any of those in retreat lag or drop behind and are attacked by the advanced vessels of the pursuers, then they must be either supported or abandoned; in the former case a general action with the ram would eventually ensue, greatly we think to the disadvantage of the fleet that was in retreat.

Diagram, Fig. X, represents a fleet (A) formed on their chiefs in two

quarter-lines charging another fleet (B) formed in columns of divisions in line abreast, the latter being the same phalanx formation which we personally so much esteem, and in whose very compact ranks all the ships so well support each other; which offers the same strength on either front, flank, or rear, and from which course can be altered together either to the opposite direction or at right angles, still leaving the disposition or rather the formation of the fleet unchanged; while a four point alteration of course only puts the ships in the columns into a four point line of bearing, which would also be a fairly simple and useful formation in which to make a ramming attack. It is not the same with Fleet A.

But were it not for these advantages which are inherent to the formation of Fleet B, we would fully admit and even advocate the power of the wedge-shaped formation in which Fleet A is formed; most powerful indeed is it as long as its apex is presented to the enemy, but it would be weak indeed if it were taken on either flank through being outmanœuvred by the enemy.

When a fleet (A) can be brought to the attack of another fleet (B) formed as we present them in our diagram under discussion, we say that to develop the full powers of the wedge the ships of Fleet A should, as their chiefs close Fleet B, rapidly edge in towards them, thus giving them great support, and giving a great chance of successfully breaking up the phalanx of Fleet B. It is evident here that Fleet B would find it more difficult to secure its victory than against any of the other formations which we depicted.

The advantages or disadvantages of the whole of the before-mentioned formations apply as well to the attack of torpedo-vessels as to the attacks of armour-clads, we presume that the former will also when in any numbers charge each other and try the issue with the ram.

We hold that when it is necessary to make a large alteration of course in sight of an enemy, the ships of a fleet should always alter course together and not in succession; ground should be taken to the right or left, ahead or astern, so that a return to the original course also ensured a return to the original formation, this formation to be favourable to an attack with the ram; once placed in a favourable position for such an attack there should be no doubt as to the next course, it should be ram on to the enemy. On first sighting an enemy any alterations of course which are requisite may be made by signal, but the order to charge being once given, it will then be alone the practised eyes and steady nerves of the different Captains that can give due support to the movement of their chief; previous to this we think it is important that all large changes of course or formation should be as much as possible avoided, a reserve of speed should be husbanded in all ships ready for the charge.

In connection with fleet manœuvres, it seems most advisable that the military masts of our new ships should bear long if slight topmasts, from one of them the Admiral's flag should flaunt high above the smoke and turmoil of the battle, it should be the one guiding star and rallying point of his Captains.

We entirely demur to the idea which has been discussed of the Commander-in-Chief of a fleet taking his post in some fast despatch vessel, from whence, outside the turmoil of the battle, he could signal and direct his fleet. In the first place we say that he could not do so, at the moment of the charge he would be helpless, in the second place he dare not do so: how could he in case of defeat meet the aspersions that would assail him? No! we hold alone with the traditions handed down to us from our glorious progenitors, well imitated as they have been by the gallant American Admiral Farragut at the battle of Mobile Bay, that it is still the duty of the chief to be in the very forefront of the battle; where the flag is seen flying there will the ships always rally.

Our future leaders must never forget the generous emulation of Nelson and Collingwood at Trafalgar.

We have already hinted at the advantages to be gained by selecting the ships that compose the respective divisions and subdivisions of a fleet, having special regard to obtain a similarity of speed and equality of manœuvring powers; where these quantities vary so greatly as they do at present, it would never do to assort the fleet in these days according to the seniority of its Captains; where ships vary in speed from 10 to perhaps 16 knots, the strategic value of an equality of speed in each subdivision is obvious. For instance, the Admiral could detach the fast 16-knot ships, who we will say formed the second subdivision of his fleet, against a retreating enemy, supporting them in their advance by closing up the next fastest subdivision, and so on, without destroying the order of sailing or disorganizing the formation of his fleet. Again, to facilitate a fleet manœuvre, it may often happen that the fast subdivisions can be made to perform that part of an evolution which requires the most speed, leaving the slower subdivisions to make good their best speed in the direction that the fleet was proceeding.

Or we may have one subdivision of each division composed of swift torpedo-vessels of the "Scout" or "Polyphemus" type, the other being composed of armoured vessels; the strategical advantages of such an organization would be great.

Chapter IX.—*Attack and Defence of Ships; Manœuvres of Squadrons and Single Ships.*

The attacks of squadrons and even of single ships will much resemble and be generally subject to the same conditions as the attack of fleets which we have before described; but more generally in the actions of single ships we opine that the gun will be the arbiter of victory in place of the ram and the torpedo. The same advantages, or perhaps greater, will be assured to the ship with the highest speed; it is the most rapid squadron or ship that can at will ignore the enemy, or deliberately choose its own time or method of attack, it can at its pleasure limit the action to an artillery duel, or force the use of the ram and the locomotive torpedo.

It will be found on trial no easy matter for a single vessel to ram a

well-handled and active adversary, unless the ramming vessel has not only a higher speed, but also a better turning power than her enemy; speed alone, though it will place her at will alongside her foe, will not of itself enable her to ram him. While seeking to ram another vessel, the would-be rammer will have to repeatedly expose himself to the attack of his antagonist's locomotive torpedoes; but he will, of course, also in like measure have frequent opportunities of using his own similar weapons.

We shall endeavour to illustrate the hopelessness of such a ramming attack by a diagram, which represents two vessels, *x* and *y* (Diagram, Fig. XI); *x* has the least speed but the best turning powers; if *x* refuses to accept an "end-on" ramming encounter, it will be seen that the superior speed of *y* will not suffice to ram *x*.

The apparent distances travelled in our diagrams are necessarily foreshortened and are not drawn to scale; it is almost needless to say that if *y* exceeds *x* in speed, say to the extent of two knots an hour, if it is a stern chase she will take three hours at least to get within fighting distance of *x*, that is if the weather be clear and the vessels should descry each other on a distant horizon; but if *x* awaits the approach of *y* or steams to close her, one half hour or thereabouts will place both ships within gunshot of each other. It is more than probable that they will both commence the action with gun-fire, but *y* is impetuous, and feeling confident in his speed, wishes to ram his adversary, who declines to accept this method of encounter, preferring, perhaps with good reason, to limit the fight to guns, or guns and torpedoes. Upon *x* deciding not to accept the ramming attack of *y*, he must turn away and thereupon *y* will pursue him (see Diagram, Fig. XI); here *y* has commenced his pursuit of *x*; from this position both ships will eventually attain the relative positions shown in Fig. XII, and we presume that they will both be still maintaining a heavy fire on each other. Barring accidents *y* will soon have closed *x* near enough to allow him as in Fig. XII to put his helm hard a-starboard and so endeavour to hit *x* with his ram; but *x*, putting his helm also hard over at the same time, avoids the blow, and in a few seconds he will have ascertained that *y* by reason of his inferior turning power can never touch him; as long as he (*x*) elects to continue on his smaller circle *y* can only steam round him on a larger circle; *y* may outpace *x* and perhaps cross his bows, but it would be a dangerous experiment.

After this attempt, it is probable that *y* will take up a position on the bow of *x* and endeavour to decide the battle by artillery, or perhaps, being strong in the use of the Whitehead torpedo, he may place himself so as to most advantageously use that weapon. Ramming can now never be successful unless one or the other of the opponents be disabled by gun-fire or torpedo, or else commits some serious error of judgment; such catastrophes may occur as well to the one as to the other, there is no reason why they should favour the ram of *y* more than they do the ram of *x*.

Our diagram very forcibly illustrates the necessity of a ship placed as *x* is in Fig. XIII being competent to put her helm hard over rapidly by steam power, the slowness of manual labour would never allow her

to avoid the impending attack of *y*'s ram. In all ramming encounters it is most imperative to safety that ships should possess the power to put their helms hard over when going at their highest speed. We are by no means sure that our own ships are well found in this matter.

If, however, in contradistinction to what we have just illustrated, *x* should decide to meet the threatened ramming attack of *y* by a counter ramming attack, the ships will meet as we have described in a previous chapter, or rush swiftly past each other, pouring in a rapid fire; here machine-guns and repeating rifles will play a decisive part in the battle. This was well exemplified in the encounter of the "Bouvet" and the "Meteor;" these vessels at first tried to ram each other end on, but missing, rushed past each other, the rapid fire poured in by the "Bouvet" on passing was most destructive to the crew of her adversary.

A good repeating rifle ought to be the naval small arm of the future not only in ships but in boats, especially in torpedo-boats; a rapid-firing small arm will be essential to success on many occasions. The French have introduced a repeating rifle into their Navy, and their Officers speak highly of its merits, although our own authorities allege that it has some imperfections.

It is needless for us to attempt to follow up this attack; after the vessels have rushed past each other nearly everything will depend upon the nerves and courage of their respective Captains, as well as upon the amount of training and good seamanship that they have acquired. We have not the space at our disposal to enter deeply into the various stratagems and manœuvres that might be practised by that Captain who was a well-trained adept at ramming; also we need not follow out the question as to whether either vessel should, after passing, turn to the same or in the opposite direction to her adversary; it will be sufficient for us to admit that an entire essay might be written on the subject of manœuvring ships so as to ram or to avoid the ram, and the question is terribly complicated by the developments of the locomotive torpedo. What we could say if we had the space to do so, would in great measure be a repetition of the writings of Captains Colomb, Noel, and others, or of Admirals Randolph and Fremantle, or of the French Admiral Bourgois, all of whom have ably handled their subject.

But we do think that it especially appertains to our essay to show the greater advantage that two ships have in attacking one, owing to the ram, than they have heretofore had; an advantage that is most certainly relatively far greater now than when sea battles were decided by gun-fire alone; then it was two to one, now it is still two to one; but in the old days the single ship could ply both broadsides against the two engaged broadsides of her adversaries; now it will virtually be, as far as the ram is concerned, one ram *versus* two rams. In Diagram, Fig. XIV, for instance, let us suppose *x* to be a single ship attacked by two vessels faster than herself, *y* and *z*, all three vessels being of about the same turning power, armament, &c., or we may even allow *z* to be inferior in size to *x* and of less powerful gun armament; but

while weak on these points she is yet equally well fitted to ram or discharge Whitehead torpedoes.

Before commencing the action y signals to his consort, "I will endeavour to force a ramming attack or make x avoid me; you keep well outside the circles we shall describe and seize your opportunity to rush in and ram him when it occurs." Thus hunted, x should theoretically in due course be rammed, if not by y at least by z, as will be seen by our diagram.

We may imagine that y will keep up a continuous fire while he is hunting x, not only for his own preservation but to confuse his opponent and take his attention off the movements of z, who should with calm precision await her chance; it is necessary that y should stick close to the port quarter of x so as to prevent him from turning to port; in this position his ram will threaten the rudder and screw of x who will have to be most careful.

These are the vulnerable points of all vessels, the least touch of the ram will be sufficient to jam the rudder or smash the steering gear; equally liable will be the screws to injury or derangement.

But instead of planning the destruction of x in the way we have so roughly delineated, it is open to y and z to place themselves on either quarter of x as in our next diagram (Fig. XV), when each ship will do her best to hunt x across the bows of her consort, much as two greyhounds hunt a hare as indicated in position 3, when z is able to ram x.

It is hardly within the scope of our essay to discuss the attack of gunboats on large ships, except to mention that the larger vessel who has accepted combat with gun vessels or gunboats—which by reason of her speed she should usually have the option of declining—she might endeavour to hunt them down one by one and so sink them, but we should not advocate the gunboats awaiting such an action, for we hold that by reason of the recent great improvements in quick-firing and machine-gun fire, in addition to the improved methods of mounting and greatly increased arc of training, &c., that can now be given to large guns, the attack of gunboats on large ships is at the best a very hazardous proceeding; the large vessel should in the open waters be able to close and overwhelm them one by one by sheer force of her superior gun-fire.

For the attack and defence of harbours, gunboats will find more suitable work than by venturesomely attacking large ships, and we shall have more to say of this in a later chapter. We must remember that, even in the old days, gunboats seldom ventured to attack even a frigate unless she happened to be becalmed and helpless.

For the purposes of attack and defence we still favour what gunboats cannot well carry, *i.e.*, the retention of armour, even of a moderate amount, in all ships, to be placed more especially on the vital parts, such as the machinery, boilers, steering gear, and conning tower; at least two guns should also be protected with armour in all ships large enough to carry it; in smaller vessels protection should be given by steel shields to the guns' crews, so as to save them from the hailstorm of machine-gun fire which would otherwise rapidly sweep down the men.

In the attack and defence of ships it will be hopeless to expect the unarmoured ship to be, except under some very exceptional circumstances such as being an exceedingly swift torpedo-vessel, successful against an armoured ship. In the matter of small and swift torpedo-vessels, the unarmoured may, it is true, by seizing their opportunity, destroy the armoured vessel, but where there is any general similarity of size, speed, and armament, the armoured vessel should have the advantage.

We may, however, in future naval wars see an entirely new phase in ship actions entirely different from those we have attempted to depict; we may, for instance, have an engagement between two vessels constructed to fight on entirely different principles, such as a fight between a corvette and a large torpedo-cruizer, such, for instance, as our new "Scout" class, whose strong point is alone her torpedo armament, while the corvette would rely mainly on her gun-power. On the meeting of two hostile vessels, the one being a "Scout" and the other we will say like our "Canada," it will be evident without much reflection that the only chance for the former is to rapidly close with her adversary, and that her chances of success or failure hinge entirely on her getting within 300 yards or effective Whitehead torpedo range before she has been knocked to pieces by the superior gun-fire of her opponent; at this short range, few shot or shell should miss her, but she should all the same, if once there, surely get a torpedo home to the bottom of her enemy. We do not insinuate that our "Scouts" are designed for this sort of engagement, especially in the day time, but at night or during thick weather their chances of success are good; it is established beyond the need of argument that such vessels are a necessity of modern naval warfare, they would be especially valuable as the consort of a big armour-clad vessel, which they would save from much work that would involve a heavy coal expenditure, they would be invaluable to beat off a torpedo-boat attack on such a vessel, and their exceedingly formidable torpedo armament will even allow them to take an effective place in the battle array of a fleet.

Chapter X.—*Attack and Defence of Ships; Torpedo Attack and Defence.*

Both in the battles of fleets or squadrons, and also in the action of single ships, the greatest possible advantages may be derived by the one or the other of the antagonistic vessels, who can make the most intelligent use of a strong supplementary force of torpedo-boats or torpedo-vessels. The active co-operation of such craft will be in many cases absolutely essential to success.

We are confident that in the future these swift boats will be made more seagoing than they are at present; even now a larger and far superior class of boats are being constructed both at home and abroad; these new boats will on most occasions be able to accompany a fleet on a short cruize or from port to port, being attached either singly or in pairs to individual ships. It will be the duty of the parent

vessels to keep their tenders well equipped, coaled, and supplied with water and provisions; under their protecting side they will take shelter, until they are close enough to an enemy to rush rapidly out and discharge their torpedoes. A sudden attack of this kind would be sure to confuse any ship who was manœuvring to ram or avoid the ram of a hostile vessel, it might even tend to throw her across the ram of her opponent, or *vice versâ* the threatening ram may materially assist the onslaught of the torpedo craft, to say nothing of the great advantages to be gained by such a diversion in the way of drawing off or dividing the full force of the machine-gun fire, which would otherwise be relentlessly poured into the opposing ship alone.

If a large proportion of torpedo craft form a part of the strength of two hostile fleets who are about to engage each other, it is probable that both the torpedo flotillas may be advanced, or be otherwise detached to fight a separate action on their own account, outside and immediately preceding the impending fleet battle. The possession of a preponderating force of torpedo-boats, cruizers, and hunters will be so beneficial to the fighting strength of a fleet, that it is hard to say what will be the eventual limit of their numbers. We may be sure that the first efforts of any Great Power who has embarked on a maritime war will be to rapidly augment her torpedo forces; all sorts and descriptions of fast vessels will be either purchased or hired and then fitted as make-shift torpedo craft; their armament of Whitehead torpedoes being supplemented with machine and quick-firing guns; at the same time every effort will be made to produce *bonâ fide* torpedo-vessels with the greatest possible facility.

We have in the American civil war a very notable example of what can be done in the way of extemporizing a naval force; both the Federals and the Confederates made use of any vessels they could lay their hands upon. And again, in the Chilian and Peruvian war, the Chilians made good use of the "Angamos," a merchant steamer armed with one long-ranging gun. It is of course undeniable that merchant or passenger vessels, which are thus extemporized as war-vessels, can never be the equal of those vessels which have been carefully designed and constructed to fulfil the purposes of war; but all the same, any vessel with high speed that can be armed and utilized with machine-guns and torpedoes, becomes an unit of naval power, and a combination of these units must be classed as an important factor in the naval strength of any country.

It is thus that we hope to see torpedo warfare utilized and adapted as an integral element of England's naval power; we have always mistrusted the power of the very limited number of battle-ships in which we have of late years at great hazard to ourselves reposed our confidence. The cost of such vessels is so enormous that we are convinced that it is vain to indulge in the hope of their numbers being ever sufficiently increased, our respective Governments, no matter whether Conservative or Radical, bidding as they always do to catch the votes of the taxpayers at the next election, dare not vote the high sums necessary to give us an adequate fleet of armour-clads; we mean a sum sufficient to put our fleet on such a permanent war-

footing as to render it equal to any possible combination of foreign Powers or other hostile emergency. The endurance or staying power of our armour-clads is so bad in connection with the wear and tear of boilers and machinery, that we cannot be justified in ever considering more than two-thirds of the total number as efficient.

Then, if this be so, we surely ought to recognize with thankfulness any means by which we could on the outbreak of war rapidly augment our naval strength.

Most fortunately, then, if rapidly extemporized craft can be a source of naval strength, we have in England this ball at our feet; there are in daily use numerous small and fast vessels, which might be put on our Admiralty register for hire or purchase in the event of war; and again, our maritime resources permit of our constructing such vessels in great numbers with unequalled rapidity.

If the gun were the sole arbiter of naval warfare, such craft would be useless and unavailable for war purposes, for many have neither the requisite tonnage and none have sufficient strength to carry guns heavy enough to batter in the side of an armour-clad or protected vessel, but they may now be easily made the equal of armour-clads as far as torpedo power is concerned.

We are often disposed to think that the time is not far distant when ancient history will be repeated, and that in the naval wars of the future we may, instead of finding the opposing fleets of two nations when sent out to fight limited to some twenty large ships on each side, find them consist, as they did in the days of the Greek, Roman, and Carthaginian sea-fights, of some three or four hundred vessels. Anyhow it is evident that the ram and the locomotive torpedo have a strong tendency to drive us in this direction.

If this does happen, and we think it will, it must be to the manifest advantage of old England, with her unrivalled naval resources; we do not think that the ironclads of to-day or of the last quarter of a century at all coincide with the ancient traditions of our Navy and its seamen.

It was not by reason of the strength and hugeness of their ships that our seamen of old overcame the Spanish Armada. Here, so far as the size of their vessels were concerned, they were quite overmatched; but the well-handled swiftness and agility of the English vessels, added to the good seamanship and bravery of their Officers and crews, under God's directing Providence, drove the monster Spanish hulks out of the English Channel, only to find disaster and shipwreck during their retreat on other parts of our coasts.

We ought never to forget that the glorious development of our war Navy with which we are so familiar is only a slow growth resulting from the daring, persevering, and ambitious merchant-trading of our seafaring forefathers.

It is a fact, however, that the press-gang and seventy years of naval peace had in combination with other circumstances in great measure separated the two great services of England, her war and mercantile navies, but we rejoice to see that of late years there has been a tendency to consolidate them; it should be the daydream of our

statesmen to make both the ships and the men of our vast mercantile marine a subsidiary force in time of war.

We have said much in favour of small torpedo-boats, particularly for night attacks on anchored vessels, but we do not under-estimate the power of machine-guns carried by such vessels as we have just advocated, and we would now endeavour to make it clearly understood that we think that since the construction of torpedo-hunters and torpedo-cruizers, and the great improvement in machine-guns, the smaller class of torpedo-boats do not now stand relatively in as good a position for ship attacks as they used to do a year or two ago.

We say, without hesitation, that the attack in daylight of say half-a-dozen torpedo-boats against even a slow armour-clad ought undoubtedly to be beaten off, though if they converged on her from the different points of the compass, she might be in a position of considerable danger; we say even a slow armour-clad purposely, for against a fast armoured vessel, such, for instance, as our "Colossus" or "Collingwood," they would have but a poor chance of success.

To ensure victory, torpedo-boats ought to have a large excess of speed over any vessels they may attack in the day-time; then with them, rapidity alone means success, the want of it, destruction.

But, as we have said before, the day attack on a costly ship is not necessarily limited to three, four, or even half-a-dozen attacking boats; by using, say thirty boats for an attack on a modern armour-clad we should not have reached her total cost, by using fifty we still have not much exceeded it, the loss of half these boats could be replaced in a few months, but sink an armour-clad by one or two of their torpedoes, and it would take at least three years to replace her.

The attack by day of fifty torpedo-boats against two or three armoured vessels would be a very serious affair for the latter; we can only compare such an attack to one of those of which we read of men on foot being attacked by a herd of the peccaries of South America, many would fall to the rifles of the men, but without shelter for the men numbers must prevail; the resolute attack of fifty torpedo-boats ought in smooth water and under favourable conditions certainly to prevail against unsupplemented armoured ships. The ability of torpedo-boats to attack large vessels must naturally much depend on the state of the weather, while torpedo attacks benefit by thick weather, it would yet be the direst folly to suppose that our present first class boats, even if their Whiteheads could be relied on, could successfully attack armour-clads in a heavy seaway; their reduced speed would place them at the mercy of the larger vessels. Large torpedo-cruizers of the "Scout" class would not do a great deal better; it is but just, however, to say that we can find very few records of naval fights in heavy weather; we may presume that they will still be the exception and not the rule.

The problem being given as to what would be the quickest and surest way of providing a power capable of destroying a given force of armoured vessels, whose destruction was necessary at any cost, it

can only be answered by urging the construction of numerous swift and powerful torpedo-vessels; it would be too slow a process to construct an equivalent force of armour-clads. The latter could only be most hurriedly built in from two to three years; given the necessity, we in England, with our present resources, could create and equip a very numerous flotilla of torpedo-boats in from six to nine months.

During the next maritime war the waste in torpedo-boats will be enormous; their construction is naturally most fragile, and hard night work and constant steaming, especially when in company with a squadron, would be most trying both to the boats and to their crews, to say nothing of the frequent casualties which must happen to them when engaged with the enemy.

The day attack on ships by torpedo-boats will, as we have already said, always require a large force of the latter, co-operation must be their motto; their attack must be simultaneous as well as swift.

If the ship to be attacked is given time, that most essential of all elements in beating off a torpedo-boat attack, she may be able to destroy most of the boats in detail.

A flotilla of fast torpedo-boats when meeting an enemy's vessel at sea, and the day and weather being favourable to their attack, should spread themselves around her at a distance of at least two miles as in our Diagram, Fig. XVI, where we represent ten boats spread with the view of an attack on a ship; from these positions by preconcerted signal, to be given by the sternmost boats, which would keep within sight of each other, they should make a rush for their opponent, and if in smooth water they should in six minutes from the signal be close enough to discharge their torpedoes, and then retreat if necessary. Six or even ten minutes seems but a short time to destroy ten rapidly approaching boats, and we doubt the possibility of its being done.

A gun or rocket should be the signal to close.

In the above diagram it is evident that if one of the ten boats is able in the course of these few minutes to get a Whitehead torpedo home, it is all that will be wanted, success being ensured even if half the torpedo-boats have had to succumb or sink under the vigorous and well-directed fire of their victim, who has to contend against her own smoke and the confusion that such an attack on her would be likely to create.

To our mind all experiments that have yet been made in destroying torpedo-boats by machine-gun fire have grossly favoured the guns at the expense of the boats; we insist that it is a totally different affair, coolly firing when steaming at 10 knots towards one drifting or anchored boat, to firing from the platform of a ship with some motion, and with the men who are firing all under the influence of the strongest excitement at perhaps ten boats approaching from different directions at a 20-knot speed.

If the machinery of a torpedo-boat is not struck and disabled, it will take very hard hitting to stop her, at high speed very little water enters the boat from small shot holes.

In a rapid attack of this nature no time would be given to the

armoured vessel that was attacked to stop and rig out her nets; and as to the feasibility of a vessel cruizing with her nets rigged out, the idea is to our mind preposterous.

We regard crinoline protection to armoured ships as a fallacy, though we do not despair of seeing ere long a class of vessels built that may be fairly proof against the attack of locomotive torpedoes, but it will not be from crinoline protection that they will obtain their immunity, but from the stoutness of their bottom, their numerous cells and internal subdivisions, and the skilful way their engines are secured from the effects of an outside under-water explosion.

We would not, however, despise a crinoline protection if it were fitted to a vessel which was solely to be employed in removing submarine mines placed outside a harbour, or in some channel or passage that must be cleared; under such circumstances there is room to lose speed to secure protection, and we think the next war will see some such class of bottom-protected vessel developed and employed for such work; but for seagoing work, anything that would so retard the speed of a ship could not be tolerated for a moment; let us picture to ourselves the anger and vexation of one of our Captains who was unable to overtake a foe through being encumbered with a crinoline protection.

Whenever a ship was attacked by torpedo-boats in the way we have described in Diagram Fig. XVI, it would seem to be the best defence for her to rush at two or three of them, and endeavour to single them out for speedy destruction, trusting to be able to avoid the discharge of their Whiteheads, rather than await a joint attack.

If the day attack of torpedo-boats be as formidable as we have represented it to be, then a night attack must, of course, be infinitely more dangerous.

To give our idea of a night attack on a fleet of torpedo-boats, we shall have to quote from a paper read at the Royal United Service Institution and published in its Journal, vol. xxviii, page 30; it so entirely represents our views on such a matter that if we attempted to explain them without quoting or referring to it, we might be justly accused of plagiarism.

This paper says: "We will suppose an enterprising and determined enemy, commanding a force of some twenty Thornycroft torpedo-boats. He has ascertained (how we need not enquire) the actual force and position of a hostile armoured squadron on some particular night, the weather on the occasion being favourable to a torpedo attack. He issues orders to his torpedo-boat force somewhat as follows:—From information that I have received, I expect to find an armour-clad squadron of the enemy 50 miles north of Ushant. I contemplate seeking and attacking them about midnight. It is my direction that you are in readiness to proceed in company with me at 8 P.M. You will then weigh together and take each other in tow in order of seniority. It is my intention to steer to the north at 10-knot speed. The greatest caution is to be preserved in regard to silence, all lights are to be thoroughly concealed and covered. It is my desire that any look-out vessels or guard-boats of the enemy should

be most carefully avoided. But should they discover us and action be unavoidable, the four sternmost boats are to cast off and endeavour at all costs, and regardless of hazard, to sink or destroy them, parting company then and there from me, and returning to port at their own discretion.

"On discovering the enemy you will by my order cast off and, forming line abreast, dash for him at your highest speed, acting independently of me and of each other, using your utmost exertions to successfully fire your torpedoes, which, having expended, you will, after the attack, having to the best of your ability supported each other, return to port also independently of me.

"I pause here to ask if a squadron of armour-clads when at sea and unaided are efficient to successfully combat an attack of this nature. Those who know the condition of a squadron on a dark night at sea, and who have seen the uncertainty that ensues when two or three ships are thrown out of station, or the watchfulness and caution required during the performance of any manœuvre involving a large alteration of course, can best imagine the effect of twenty swift vessels approaching, covering the mile that they will be seen easily under four minutes, &c. . ."

If this description of a night attack on a fleet is not overdrawn, and we do not think it is, what precautions must fleets take to prevent their own destruction by such an attack?

In the first place their whereabouts on any particular night must be alone known to the Admiral commanding, each evening at sunset the larger vessels must by his orders stand off together on a different course and at a different speed from the previous night, more especially so on very dark nights or in foggy weather. When it was clear enough weather and on moonlight nights fast scouts should be spread inshore of the fleet, prepared to use a well-thought-out private alarm signal, simple and thoroughly understood by all.

Now comes the all-important and as yet unanswerable question, How is a night torpedo attack to be received by a fleet? Is every ship to carry her torpedo-nets out? We say No! At sea this is certainly impracticable. Are all ships to use the electric light and search the horizon? Here again we say No! The electric light unless used with the greatest judgment may blind your friends, and is as likely to lead the attacking boats to their quarry as to discover them in time.

Then, again, are the ships to have the option of opening fire on any boats they may see approaching? There will be little time in dealing with a torpedo-boat attack to think, let alone to signal and ask permission to open fire. Once again we say No! Firing, and especially an indiscriminate firing, would lead to confusion and favour the attack; it would prevent the use of scouts, for with scouts out fire could not be opened on a rapidly approaching boat, for it might destroy friends instead of foes. If firing is to be allowed to beat off an attack, scouts must be forbidden to close until daylight. Here we have exhausted our vocabulary of the modern antidote to torpedo attack, and we have approved none of them. Our reasons are good: all the plans detailed

are more or less imperfect; there is no absolute safety in either of them. Well, what can we suggest? As far as they go, nothing. To my mind the one way to successfully meet torpedo attacks will be by counter-attacks, not made by monster armour-clads, which latter should be carefully moved away from the possibility of such attacks, each night to a fresh position, which will be signalled to the fleet before sunset on each day, and who when moved might then lie, if in absolutely smooth water, with their torpedo nets spread around them, showing not the vestige of a light, trusting to the vigilance of their smaller allies for their safety during the night. But if it was absolutely necessary for the due execution of the duty required of them that a fleet should lie in the vicinity of a port known to contain torpedo-boats, then one or all of the precautions we have referred to might at the discretion of the Admiral be adopted.

One of the first things to strive for would be that the egress of the port should be illuminated by the electric light, so that any vessels coming out should be detected. Two vessels might when possible be stationed to throw the rays of their lights on the entrance; in their shadow numerous torpedo-cruizers, hunters, &c., should lie in wait ready to pounce on all who came out into the beams of the lights. Where the depth of water admitted a series of mines might be laid outside the port to hinder the exit of large vessels. But increasing and unwearied vigilance must be the great safeguard, and constant feints and attempts to cut out or blow up vessels in the port must be the invariable reply to a torpedo-boat sortie. The blockading force should daily and nightly strive to keep the defenders so harassed that they should be unable to organize counter-attacks. As we have more than once said, armoured ships of any size are too costly and otherwise quite unfitted for this work; small and active vessels must do it, who should use the armoured vessels as their base of operations. It would be most desirable in a strategic point of view if the armour-clads could seize and fortify any harbour in the vicinity of their operations wherein they could occasionally rest, coal, and make good small defects, &c., while in very bad weather when the blockade could not be either maintained or easily broken the ships might find a safe haven.

The great danger of torpedo-boat attacks is of course the extreme uncertainty of the time and place when they will be made; these small and swift boats might be taken in fine weather at least 60 miles from their port for a night attack and be home again at daylight. It will be almost an impossibility for a fleet to watch ports 60 miles on either side of them; undoubtedly, steam and torpedoes greatly militate against an effective blockade, and they are both in this way a disadvantage to a naval Power like ourselves, who could in the old days fairly well blockade the coasts of our enemies.

But great speed is not alone of use to the blockaded or those who wish to run the blockade. In our next chapter we shall hope to show the material advantage it can give to the blockaders.

When vessels have been brought to an anchor within the range of a possible torpedo attack there are many ways to defend them against

the night attack of boats armed with Whitehead torpedoes, and more easily against the attack of spar torpedo-boats; but we know no way of defending them from the attack of rams or large torpedo-vessels except by an elaborate system of electro-contact submarine mines; all other obstructions could be so easily forced by powerful steam vessels that they are hardly worth thinking about; we say, therefore, that where there is a possibility of a combined ramming and torpedo attack, a fleet should not be anchored unless the entrance to their anchorage was narrow and was elaborately defended by mines.

One method of defending vessels at anchor against night torpedo attacks would be to have an arrangement of floating grass lines, one behind the other in series, about 700 yards from the ships, each line to have distributed at intervals along its length small buoys or floats, each float to carry a Holme's light so fixed as to be quickly submerged if a torpedo-boat fouled the line. These lights are at once ignited on contact with water, and continue burning, being most difficult to extinguish. If, then, a system of grass lines were laid on this plan across a harbour's mouth, and guns were placed so as to both rake and enfilade them, the moment a torpedo-boat fouled a line and immersed one or two buoys in her vicinity, then the electric light should be turned on and a heavy fire opened. The firing should cease after a very short interval, when guard-boats should at once sally in pursuit of the enemy's boats. Any plans of this kind should be most carefully pre-arranged; in a defence against torpedo-boats nothing must be left to chance. You have already to contend against the probability of the confusion likely to arise from the sudden attack of unseen foes without adding to the danger by allowing indiscriminate firing, which might result in ships firing on their own guard-boats or even into each other.

Another plan would be to trust more to the electric light; this should be arranged so as to cover the whole zone of approach to the ships, which should be moored with their guns carefully laid for it to be fired by electricity by the Officer on the look-out immediately a boat entered the illuminated zone. It has been proved that the rays of the electric light greatly confuse approaching boats, and render it very difficult for them to estimate their distance from it. The side of the ships exposed to attack should have nets outrigged from it, and a further system of floated torpedo-netting, moored about 50 yards distant from this. We hardly think a torpedo-boat could have much chance of success against this system, but it could only be applied to a narrow harbour with one approach. A large vessel could of course force this with ease, but she would have first to run the gauntlet of the cruizers left in the offing and the guard-boats armed with the Whitehead torpedo which would be stationed along the shores.

A boom, such as was used in the late experiments at Berehaven, will of course stop a torpedo-boat, but it takes too long to fit to be called an extemporary defence, and in war-time we doubt if the necessary spars would be available; they would indeed be far better landed at the dockyards on the outbreak of war.

There will be many ingenious methods used as defences against

torpedo attack in all future naval wars; their nature will depend entirely on the circumstances in which the ships are placed, and on the resources and ability of those who employ them.

As to torpedo-nets, we are of opinion that they are undoubtedly a most valuable defence against Whitehead attack, but they by no means render a ship invulnerable. To be fairly efficient they should be spread at least 30 feet from the ship's bottom, that is to give entire safety from a Whitehead that happened to explode in them. It is by no means sure that they will explode a Whitehead if its whisker is first removed, in which case the striving of the torpedo to get ahead will, before its motive power be expended, force the net close in to the side. If a Whitehead does happen to explode by striking a mesh of the net, the latter will be assuredly blown inboard, and a large space left open for another torpedo to get home. Instances have been known of the new and improved Whiteheads running at high speed[1] breaking clean through an ordinary torpedo-net.

It would seem preferable to attach the torpedo-nets to a row of buoys and boats moored well outside the ships rather than round their sides, lashing the ships, that is if they were in a well-sheltered harbour, close together behind the nets, in as small a space as possible, having in addition a well-organized protection of guard-boats and electric lights at the entrance of the port.

Any attack by larger vessels upon a net thus laid should be beaten off by launches armed with the spar torpedo; two or three launches thus armed being secured at either end of the nets with steam up and torpedoes fixed in readiness to slip at a moment's notice.

So satisfied are the French with their recent successes in China with the spar torpedo that they have made arrangements to supply all their war-ships with an increased supply of that weapon. Though we ourselves think the Whitehead of more value for most purposes, and more especially so for use against large ships, yet we amply recognize the fact that for all attacks on gunboats, gun-vessels, and vessels of shallow draught of water, the spar torpedo is the most suitable weapon.

The main point to our mind in connection with the prevention of ever recurring and perhaps successful torpedo attacks on our ships and fleets will be to take good care that those who make such attacks, whether successful or unsuccessful in their object, should be captured and destroyed. This, ironclads of themselves cannot always do, but their attendant torpedo-boats, torpedo-hunters, &c., should, if of the right sort and well found and equipped, be fully equal to the task. The prospect of performing dashing feats, which will be open to the younger Officers of the Navy in the next war, has never at any period of our naval history been exceeded, and we are happy to think that we have both the Officers and the men who will be fully equal to their opportunities.

For a vessel simply to await and sustain torpedo-attacks wrapped

[1] Our torpedo experts think that soon the Whitehead will be capable of running at 30 knots' speed for 300 yards.

up in her nets like a hedgehog, or enclosed behind booms, or in "naval zerebas," like that constructed by our recent evolutionary fleet in Berehaven, is only to invite further and oft-repeated attacks; whereas after the clever destruction or capture of a dozen or so of torpedo-boats in the way we have propounded, we should hear far less, or perhaps none of that tall talk so freely indulged in by the inspired newspapers of a certain unwieldy foreign Power as to their organization of "pig sticking" and "hunting clubs,"[1] to be mainly constituted for the destruction of British armour-clads. It has frequently amused us to see how completely these papers thought they had only to send out their torpedo-boats at pleasure to hunt and blow up our armour-clads. With properly equipped torpedo-cruizers and torpedo-hunters the hunting might be quite the other way, and the would-be hunters and pig-stickers might in their turn find themselves the hunted.

We well know and respect the formidable powers of the automotive torpedoes, and we do not seek to underrate them; but we are convinced that they cannot be used in the same offhand way as agents to destroy our fleets as some other nations are pleased to imagine; and it seems somewhat unwise on their part to presuppose that we may not excel in their use afloat as greatly as we have done in the old days with the older naval weapons. We certainly and undeniably have far greater power to create a flotilla of fast torpedo-vessels in a hurry than any other nation, our only danger being the fearfully unprepared state into which we drift during time of peace through the observance of a thoroughly false and in the end expensive economy.

We think that the adoption of the rapid and "turnabout" torpedo-hunters proposed and constructed by Mr. White, of Cowes, will do much to lessen the terror which torpedo-boats have inspired; such a vessel as that torpedo-hunter, of which a plate is given in No. CXXIX of the "Journal of the Royal United Service Institution," page 483,[2] would make short work of our present 1st class torpedo-boats; her length is 150 feet; displacement, 220 tons; speed, 18 knots; while she will be able to turn in a little over her own length, carrying (in addition to her torpedo armament) a heavy armament of machine-guns; she, or vessels of her class, are likely to considerably influence torpedo-boat warfare of the future.

The smaller "turnabout" boats will also be invaluable as picquet and guard boats.

Our newly designed torpedo-catchers of the "Grasshopper" class ought, if their speed is good, to be, when attacking smaller torpedo-boats, veritable "Tritons amongst the minnows."

Ere we conclude this chapter, we would add a few words as to the future development of torpedo-vessels. The "Polyphemus" and "Scout" may be said to be advanced types of their class, but it by no means follows that they are to be the ultimate or sole representatives of highly developed torpedo power. Let us suppose, for instance, as an extreme case, that instead of limiting ourselves to the

[1] *Vide* certain Russian newspapers, 1878 to 1885.

[2] Commander Gallwey's valuable and interesting paper on "Torpedo Warfare."

2,600 tons displacement of the "Polyphemus," we built a torpedo-vessel of the same weight as the "Benbow," with her 10,000 tons actual displacement, and that we took away her armament of heavy guns, and confined her armour protection to a water-line belt and a heavily plated conning tower, giving her only a moderate armament of quick-firing and machine-guns, but fitting a discharge tube for a Whitehead torpedo wherever it was possible to put one, say at least eight on each broadside, two on either bow, two right ahead, and the same right astern. What we have gained in weight would allow us to give our proposed ship a seagoing speed of 20 knots, and if specially designed, better turning powers than the "Benbow." It would thus be within the power of our contemplated torpedo giant to close the "Benbow" at pleasure, when having done so she could discharge four Whitehead torpedoes to one of the "Benbow," but she cannot reply to the heavy armament of the latter, using in her attack only her machine-guns and torpedoes, then in the single combat of two such vessels the question is resolved into this: Is the superior gun-fire of the "Benbow" equal to the four to one torpedo discharge of her opponent? Which ship will be first able to sink or water-log the other?

The question is worthy of deep thought!

We distinctly wish to make it plain that in writing the above we do not advocate such a torpedo-vessel; on the contrary, we think it would be wiser to spend the same money in the construction of two "Polyphemus'," "Scouts," or other torpedo craft, but all the same, we feel that it is necessary for us to indicate a line of construction into which torpedo attack may yet lead us during its progressive competition with the gun as the naval weapon of the future.

We have not thought it incumbent on us to describe in any part of this essay how the Whitehead torpedo is discharged from boat or ship; there are various methods, such as steam pressure, hydraulic rams, launching carriages, &c. We shall not enter into any particulars of these, for we think that a small charge of slow combustion powder will be found in most cases the final and most effective method of getting the Whitehead away from its tube.

Chapter XI.—*Attack and Defence of Harbours.*

It has been claimed, and there is a good reason for this claim, that the recent advancements in the art of war have favoured the powers of forts and land batteries at the expense of the ships; meaning that it is not so easy for ships to bombard and destroy land defences now as it was in the days of the last four or five generations of mankind, whose ships, provided they could in sufficient force approach close enough to land batteries, hardly ever failed to give a good account of them.

Without any doubt it is possible to mount ordnance of unlimited weight and capacity in land batteries, it is also within the ability of the military engineer to protect guns on shore either in thickly

armoured casemates, in turrets, or in Grüson's cast steel shields of such immense thickness as to render them practically invulnerable to the gunfire of ships, in which, as we have already stated, the size and strength of both guns and plates will always be limited by weight; so that it is safe to say, that while the protection and armament carried by ships is ruled by the weight they can support with safety to themselves, in shore forts or batteries financial considerations will alone determine the extent of their strength and power.

Fortunately, however, for the ships it is quite the exception to find enough money lavished on land batteries as to render them the equal of the ships that could be brought to attack them; moreover another positive advantage always will remain with the vessels, viz., of being able to assail shore defences on their weakest points; by concentrating their fire on these, vessels may be able to overwhelm land batteries in detail. It is manifestly impossible for any nation to fortify efficiently every port and town on its littoral, it is also a fact that tells much in favour of the ships, that in this era of rapid progress, the short lapse of even one decade will render the guns of to-day, and probably the forts in which they are mounted, comparatively obsolete, and experience teaches us that most nations are very slow in securing their constant renovation by reason of the great expense that it entails.

We feel, therefore, justified in assuming that with the exception of certain large naval stations and seaports, whose importance renders their protection a matter beyond monetary consideration, as far as guns and plates are concerned, ships of war, as we now know them, will be nearly always found the masters of shore defences.

We are, however, by no means prepared to say that this state of things will continue in the future; on the contrary we think that as the value of high speed incidental to the use of the ram and the torpedo becomes, as it will, more apparent, the tendency of naval constructors will be to reduce the weight of armament and protective plating carried by ships, and so obtain more speed; we even go so far as to again express what we have before hinted; viz., that it will be found in the future that small and swift vessels combined in great numbers are potent to destroy the colossal armour-clads of to-day. If this be so, then the war navies of the future, consisting mainly of swift vessels fitted with ram and torpedo, of fragile construction and of very light gun armament, will be quite incompetent to engage land batteries, and should not attempt to do so.

These vessels would be used alone to secure the national supremacy afloat, and having secured it, they should when necessary escort slow but heavily armed and protected floating batteries to within range of the guns of the enemy's forts, and leave them to do the work of bombardment, keeping near the floating batteries in readiness to protect them in case the enemy should send out a sortie of rams and torpedo-boats.

Floating batteries could be quickly constructed in time of war and guns and plates of great thickness could be mounted on them; we do

not believe in the necessity of our keeping a force ready at all times to bombard the *coasts* of our possible enemies; what we do want is, the necessary vessels to secure the command of the sea on the first outbreak of war; having secured this, our great and unequalled naval resources could be vigorously developed in any desired direction.

We have not forgotten that the matter of the essay does not require us to go deeply into the subject of the gun attack and defence of ships *versus* forts, but we find now, as we found in a previous chapter, that it is simply impossible to make any very distinct separation of the various means of attack and defence which will be employed in this or any other branch of future naval warfare; for guns will be employed whensoever it is possible to do so for the protection of all submarine mining defences, and the mines themselves, by keeping the ships at a distance, give an immense amount of protection to the guns; being thus mutually of so much assistance to each other, we may assume that the co-operation of guns and submarine mines is most essential to any thorough system of harbour defence.

It is indeed well for the harbours of our possible foes that the submarine mine has become of such dread repute as an engine of maritime war, and that its use has, as far as our present ships are concerned, commanded such a wholesome respect for its powers. It has indeed almost become a maxim among seamen that it is their duty not to heedlessly risk their vessels in close proximity to submarine mines: if this were not so, in these days of high speed and protective armour there would be nothing to prevent any fast vessel with a daring Captain from running the gauntlet of the hostile batteries at the entrance to any port, or rapidly steaming into a gun-defended roadstead, and then when once in, either sinking with her ram any victim she chose to select, or at her pleasure literally "running amuck" amongst the whole of the shipping which was therein sheltered: a vessel like the "Polyphemus" would be well suited for such an exploit.

But where the presence of submarine mines is either known or suspected, and no matter whether the mines are mechanical or electro-contact, to attempt such a feat would be foolhardy to the last degree, and unless accompanied by the most extraordinary good luck, could only terminate in disaster to the attacking vessel.

We apprehend that whenever a fleet is stationed to blockade, with orders to subsequently attack the defences of a hostile port, the Admiral in command will first cautiously obtain any information he can get as to its submarine mine defences; should he find that there is a well-laid mine field placed under cover of heavy guns, then he must pause and take varied and most troublesome measures to make sure of removing or destroying the mines before hazarding a single large vessel in an attack on the forts. Even if a large proportion of the enemy's mines are reported to be dummies, yet the moral effect will still be great, and every precaution for their removal must still be taken.

We may assume then that the future defences of great seaports will

embrace, in addition to heavily-armed forts with turret and shield-protected guns, an extensive system of electric submarine mines; these should be backed by a flotilla of armed torpedo-boats fitted to use the Whitehead or the spar torpedo. The electric light will also be utilized to throw by night its rays over the mine field and the approaches to it; under such conditions, the work of removing or destroying the mines would be a labour of great risk and difficulty.

But all harbours will not be so effectively defended as the above; often in the less important harbours the defences will be limited to guns alone: more often from force of circumstances it will be a system of submarine mines alone that is relied upon to keep the enemy out; even occasionally the port may be only defended by torpedo-boats and gun-vessels; or its entrance may be simply barred by booms or other obstructions, vessels sunk in the fair way, &c.

The "Lay," or the "Brennan" or some other controllable automotive torpedo may also form a part of the land defence against attacking ships, and if the published reports as to the successful experimental trials of the "Brennan" are to be believed, attacking ships will be in much jeopardy from these torpedoes even at a distance of two miles.

The amount of defence afforded by the different systems we have mentioned may be briefly summed up as follows:—

Against a gun defence unsupplemented by submarine mines or automotive torpedoes, the attacking ships can at pleasure, provided the water be not too shallow, measure their strength against the shore forts or batteries, continuing their bombardment or ceasing it at will. We have of late years had several well-marked examples of this kind of attack. We name for instance our attacks of 1854 and 1855 on various Russian seaports and fortresses, the American Civil War; also the Spanish bombardment of Callao, and later, the destruction of the forts at Alexandria.

Against the defence offered by a well-planned system of submarine mines, no rash attack can be attempted. On the contrary, cautious preliminary arrangements must be adopted to ascertain by what system of mines the place is defended, and how and where the mine fields are placed; then every endeavour must be used to clear a channel for the safe approach of the ships by destroying or removing the mines. This will become an affair of careful details, such as creeping for and cutting the mine connections or moorings, counter-mining, &c. All work of this kind must be performed under the close supervision of well-trained torpedo Officers and men. Where the mines are placed under cover of batteries, these proceedings are not possible except at night or during thick weather, and even then smooth water and no tides are necessary adjuncts to success.

No attack should be made by ships on a port so defended, unless the attacking fleet were sure of their naval predominance; a defeat with the loss of several ships sunk by mines might lead up to further and more serious disasters: a blockade will have to be enforced.

In the blockade of a port, the ships that compose the blockading fleet will always be at a serious disadvantage when compared to the

blockaded ships. Amongst the arduous duties of a blockader, constant coaling will be the most serious. Steam will generally have to be ready for full speed at a few minutes' notice, and yet all boilers must be kept with tubes well swept and clean. It seems advisable that the ships which form part of a blockading squadron should be docked at least every three months so as to prevent a foul bottom diminishing their speed. The career of the Peruvian "Huascar" was terminated by the Chilian ships "Blanco Encalada" and "Cochrane," solely because the repeated requests of her Captain to have his ship docked and her bottom cleaned were refused by the Peruvian Government.

Blockading work is the most severe duty that can be imposed upon a seaman. He certainly may not have to endure such prolonged absence from his native shores, or from the pleasures and comforts of the land, as his forefathers had in our wars of not a hundred years ago; but the application of steam and the introduction of the ram, and the increasing power of swift torpedo-boats, the worries of the telegraph, &c., will not fail to cause him endless anxiety, and will require him to exert an unceasing vigilance, so much so as to demand from him an exercise of nerve and brain power to which, happily for themselves, his ancestors were perfect strangers.

We do not think it advisable that any of our systems of placing submarine mines for defensive purposes should be discussed in this or indeed in any essay. We are, however, justified in observing that all our present experience goes to prove that any system of mines to be effective at first, and to preserve its effectiveness afterwards, must not only be planned but placed in position by trained experts, and also that the best materials and most perfect workmanship must be used. Extemporized mines and inferior insulated wires, combined with unskilled workmanship, can never lay out either an effective or a durable submarine mine field. All the materials for defensive mines should be leisurely and carefully prepared and tested in peace-time. It is true that mines can be extemporized and laid down from ships at very short notice, but if made of casks or oil drums, their effective under-water existence is a short one; in a few days, or perhaps in a few hours, the penetrative and searching qualities of the sea water will have found out not only the weak places in the mines, but any faults in the insulation of their wires; while tides, winds, and currents will at the same time unceasingly do their best to injure or shift them. Mechanical or self-acting mines may be improvised more quickly and with a better chance of success than electric mines, but when laid they are dangerous and obstruct the navigation alike to friend and foe, and as for picking them up again, it would be a service of infinite danger. A great rise and fall of tide, and the consequent rapidity of current is a serious impediment to the proper laying of mines, not only from the difficulty of moving them, for it will be no use to have all one's mines bobbing up to the surface at low water in full view of the enemy, or even if they do not actually appear, yet the "twirl" caused by a swift current running over a mine near the surface will always reveal its position. We under-

stand that this great and apparently unsurmountable difficulty of making mines keep their proper depth has been overcome by the ingenuity of an Austrian Officer, and also by one of our own torpedo Officers; but their plans are unknown to us, and if we knew them, it would not be our place herein to record their secret any more than it would be if we were to explain the entire mechanism of the Whitehead torpedo. Ground mines may be advantageously used in shallow water, they are not liable to drift or shift their position, are very hard to discern and pick up, especially if silted over with deposit. Submarine mines have also been fixed on the ends of stakes or posts driven into the bottom. The Confederates made good use of this plan of fixing mines in the defence of their rivers against the ships of the Federal States.

Translucid water, such as we meet with in some tropical and subtropical waters, would be a great drawback to effective submarine mining, the mines could be easily seen by the aid of water glasses, then carefully grappled and removed by the enemy; an observer stationed aloft in a ship with the sun at his back could detect them by eye alone well in advance of the path of his vessel.

There are many and various methods of clearing a channel of submarine mines, but little has been done in this way in actual warfare; in practice, boats have swept the bottom with weighted hawsers, and so got hold of the moorings of the mines, or the torpedo "Detector" can be slowly towed by a boat along the bottom, and which, acting somewhat on the principle of the telephone, will make a buzzing sound in the receiver whenever the detector is close to any metal; or they have by creeping fouled and cut the electric communication, &c. But in actual warfare, when live mines have to be handled and not dummies, countermining will be found the safest and most effective means to destroy or remove the enemy's mines. A boat will be sent in, perhaps automatically, over the mine field of the enemy, to lay down a good sprinkling of electric countermines, these mines will be dropped, and on the return of the boat exploded; the water space or channel so cleared will be then carefully buoyed and the process repeated farther on; the heavy countermines will explode or render useless the mines of the enemy for a considerable distance on either side of the explosion; this service must of necessity be always a very hazardous one, and could not be performed under fire.

We have already stated that we believe a special ship will be constructed to assist in clearing channels of submarine mines. She will be built of low speed but of the greatest possible strength, the outside skin of the hull being perhaps 2 inches in thickness, with an extensive double bottom and numerous watertight compartments and subdivisions, the boilers and machinery being kept well within the centre of the vessel; in Diagram, Fig. XVII, we represent a rough plan of such a craft at the water-line. From her sides just above the water she should carry nine or more arms or spreaders made of mild wrought steel, these should be connected with each other and fitted to lower to a depth of 15 or 20 feet, or if necessary top up out of the water, and be supported by chains attached to stout posts or stanchions

fixed on her sides; each of the arms or spreaders should have a stout sharp-edged hook at its extremity capable of catching or perhaps severing the moorings of any submarine mine that it happened to foul, the arms of the spreaders should be well fitted and be movable and adjustable, so that those injured by an explosion could be replaced; spare arms should be carried inboard. A vessel of this type would no doubt be expensive, and she would be useless except for the special service on which we propose to employ her; she will be only one more example of the motto which is now so applicable to ships and vessels of war, "Non omnia possumus omnes;" where, however, it was necessary to force a channel leading to the attack on a seaport, and which passage must be quickly cleared of submarine mines, as constantly was the case in the Americal Civil War, expense would be a very small consideration; to get quickly at the enemy would be the one and only object; here we say, in a case of this kind, that our proposed "Removes" might render essential and valuable service; steaming slowly up and down the suspected locality of mines, those fouled could be removed or exploded or brought to the surface at a fairly safe distance from her hull.

Booms or chains moored across the entrance to a harbour can only be regarded as an expedient available against the attacks of torpedo-boats, which undoubtedly can be stopped by such a defence; but a larger class of vessel would have no difficulty in breaking through any boom however strongly it might be moored. The experimental boom at Berehaven proved that the yards and spars of ships are not well suited to form an effective boom, large logs of wood with deep grooves let into them to secure steel wire hawsers in would be much more serviceable, and would have to be provided for the defence of any harbour to which the ships of a fleet resorted to shelter themselves against the night attack of an enemy's torpedo-boats.

Probably two booms, one light and the other heavy, the light one on the outside, are best suited to prevent torpedo-boats from jumping them; the small boom will check the boat's speed, having lost this, she will be unable to regain sufficient impetus to clear the inner and stouter boom.

All sorts of floating obstructions, such as nets and grass ropes, are valuable adjuncts to stop a torpedo-boat attack on ships which were sheltering in a harbour. No boom can stand the charge of a heavy ship.

The offing of a blockaded harbour will be the constant witness of many torpedo-boat sorties or cutting-out expeditions, and in this way we may depend that both blockaders and blockaded will continually worry one another. Attacks of this nature should be well suited to the abilities of our naval Officers and seamen; it is well within our power to daily scour the English Channel with torpedo-boats and torpedo-cruizers should the stern necessities of war ever render it necessary for us so to do. We have only to read any of our naval histories to see what an immense amount of work was daily done, and what gallant deeds were performed in the schooners and cutters which were so fearlessly handled by our ancestors in the days of old, to gather what

their descendants may do, if they have not degenerated, in small swift vessels, and in which they will secure all the advantages due to the almost absolute certainty attending their power of locomotion, instead of, as was the case of old, waiting for days inactive through the fickleness of the wind, or perhaps drifting helplessly becalmed when speed was most needed.

Up to the present moment we have in this chapter confined ourselves to dealing with the attack and defence of harbours in the sense that it will be generally unadvisable for ships to risk destruction among the submarine mines off the ports of an enemy; but we have not forgotten that at times it may be strategically necessary for ships to force a passage or attack a harbour, freely taking all risks; often the importance of the results to be derived from the capture of a place may justify an Admiral in hazarding the destruction of a large proportion of his vessels. Let us say, for instance, that it was necessary to force a passage up such rivers as the Mersey, Severn, or Clyde, and that if this could be done, the enemy might be compelled to sue for peace, and a prospect would be afforded of bringing a severe war to a speedy termination; it was at one time necessary for Farragut to steam his ships through or over a Confederate submarine mine field, and he did so. We may be sure that the same thing can be repeated, but it will be more costly now than it was then. Preliminary to an attack of this nature we may be allowed to suppose that an Admiral would reckon what ships he could best afford to lose, and would advance them to almost inevitable destruction, or possibly a number of hired merchant steamers may be sent on in front of the fleet manned by volunteers as a sort of forlorn hope, with orders to steam on in advance of the fleet, not stopping or turning to avoid the most certain indications of the proximity of submarine mines; or possibly the ships of war may be themselves lashed together in pairs; or more possibly a merchant vessel filled with empty casks may be lashed on each side of a man-of-war with the view of exposing them to the first brunt of a torpedo or submarine mine explosion, and to make sure of the man-of-war being able to still get ahead if her motive power were disabled. What matter if, in such a case, the sides of the merchant steamers were blown in, they could be cast off and abandoned, the object sought would be gained if only a fair proportion of the men-of-war got safely past the mines; it might then only remain for them to make their own terms for the ransom of a big city.

We have said that it is impossible to give adequate protection to every town, port, or harbour on our coasts; nor is it possible for the littoral of any country that we know of to be wholly defended by a combined system of forts and submarine mines. It will be almost equally impossible in our own case to provide for the defence of our numerous small seaports, fishing towns, and villages, by submarine mines alone, or by guns alone; mines may be used to protect the most important mercantile and fishing towns, but cannot be extended to such a distance from the shore as to preclude the ability of some hostile cruizer lying off and bombarding the place; guns may be placed so as to prevent the enemy from landing, but the cost of

mounting guns in sufficient numbers to command all approaches would be more than any nation could afford; many of our wealthiest watering places are actually on the seaboard with an open and extended sea frontage; it must be the joint labour of our most able, skilful engineers and naval Officers to decide what system of defence is most applicable to each place.

Those large towns of ours then which are actually situate on the seashore and have extensive deep water approaches cannot rely entirely on either guns or mines for their defence, they must seek protection from the Navy; gun- and torpedo-boats must be their "défense mobile." Other places which are situated further in shore, and many of which have narrow tidal harbours, might obtain a fair protection from a well-laid system of submarine mines. It is clearly impossible to propose any general system of defence that would be equally applicable to all and every place; but it cannot be denied that in time of peace it would be highly advisable to have a well-trained torpedo volunteer corps at every seaside place of the least importance; then whenever the country unfortunately became involved in a maritime war, the trained ingenuity of these men might improvise and lay down a torpedo defence for their town, which even, if ineffective, would all the same be so morally deterrent as to prevent the over-confident approaches of hostile vessels.

Personally we can never persuade ourselves that the defences of our smaller seaports should be other than a powerful war navy, a navy so strong as to defy aggression on the part of other Powers; but if our countrymen are unwise enough—as indeed they are—not to see as we see it, then of course it is undeniable that local defences should receive every attention. Nevertheless, having done all that can be done in the way of local defences, we feel assured that it will be a sorry day for England when the people of another country are strong enough at sea to attempt the attack of our littoral and seaboard, and it will be a sad confession of our naval impotence when we in our defence have to fall back on forts and submarine mines to frustrate their assaults, instead of doing as we did in our brave days of old with our ships carry the war on to a foreign coast.

Steam has placed a large section of our coast within a few hours steaming of the harbours of populous towns and powerful nations, but it has equally placed their coasts within easy reach of us; in the event of war between them and ourselves, the safety or unsafety of the various ports on either coast would much depend on the aptitude with which high speeds in both ships and boats, and the uses of locomotive torpedoes and submarine mines, have been studied, realized, and acquired by the Naval Services of the conflicting countries.

Chapter XII.—*General Summary and Conclusion.*

We venture to think that it will be well if, before concluding this essay, we should briefly summarize the results that we have striven to indicate, or which we have dealt with in our previous chapters, and which are, in the main, entirely due or consequent on the introduc-

tion of the ram, the torpedo, and the submarine mine as naval weapons; by so doing we shall tersely present our opinions and ideas to the consideration of those who have, perhaps, not the leisure to follow us through the whole of our preliminary arguments and reflections.

It will have been sufficiently obvious to those who have been indulgent enough to read what we have written, that for the present we indicate the ram as the leading naval weapon for fleet actions; we say that it is most essentially so, and that in their opening charge with the ram, artillery will have to be subordinated to its use! For other actions it has also in a great measure rivalled or surpassed the gun, but it may, nevertheless, itself have eventually to yield to the torpedo, which latter, oddly enough, while it also appears likely to beat the heavy gun, yet brings the employment of lighter quick-firing and machine-guns most prominently to the front.

For the actions of single ships the ram may perchance be inferior to the gun, and only hold about the same relative value as the locomotive torpedo; but in accepting this doctrine we must remember that even if the whole of the guns of a vessel are silenced early in an action by the superior gun-fire of an enemy, who may have knocked her hull to pieces above the water-line, yet so long as speed and steering gear are left intact, this vessel is not by any means beaten, still less captured, and she may even yet find an opportunity to sink her enemy with the ram or the torpedo, which latter may be to some extent regarded as a flexible extension of the ram.

Arguing from the above, it is evident that the existence and potency of the ram and the locomotive torpedo demand that the water-line, steering gear, and conning-towers of ships should absorb all the protection that can be afforded them; also that the ram itself, and the bows of all vessels, more especially of fleet or battle-ships, should be very strong and of the best possible construction and formation, both for making and resisting ramming attacks, and that their instalment of locomotive torpedoes should receive every attention.

Thus we hope to have demonstrated that next to the ram we regard the locomotive torpedo of the Whitehead type as a leading and potent naval weapon, a weapon with a great and almost unknown future before it, and now the weapon *par excellence* for the attacks of small vessels upon larger foes; and also as a weapon that in single-ship actions should give great results; but in fleet actions we would make its use always secondary to the use of the ram, especially in their commencement, when its general employment should, like the guns, be carefully restrained.

Locomotive torpedoes of all descriptions have united to abolish the almost absolute security that in the days of old our battle-ships were justified in arrogating to themselves; now all large vessels, more especially when they are assembled in fleets, must use increasing vigilance to prevent themselves from becoming the subject of those attacks which will at once place them at a decided disadvantage with their assailants.

Then individual perfection and similitude of type being impossible, future naval warfare will insist on the use of vessels differing greatly from each other; without this co-operation there can be no absolutely efficient naval force, the ram and the torpedo-vessel must supplement the battle-ship, which in her turn must be their base of operations. It is necessary for the very safety of every battle-ship that she should have a due proportion of swift satellites attached to her.

Large and costly ships, despite their immense fighting powers, must yet be constantly watched, guarded, and surrounded by scouts, torpedo-hunters, and picket-boats; for it is proved beyond dispute that these costly ships cannot, if unaided, protect either themselves or each other; while at night they are liable to instant assassination.

Here we have, from this cogent fact, provided we choose to follow it to a greater length, forced upon us the extreme probability that the experience which may be gained in future naval warfare will totally and radically alter the entire composition of our fleets as we now constitute them; it is indeed, as we have already said, irresistibly certain that the assortment of a war-fleet must be most composite in its character, the old array of battle-ships formed in several ranks will be only the nucleus on which to form more numerous vessels of a great diversity of type, form and power; we are not, indeed, prepared to say with any certainty how much longer the necessity for such a nucleus, or the material for forming it, may be suffered to exist. Already the battle-ship of our day is hard pressed, and it is openly confessed that her ancient potency is now half imaginary.

The naval might of a nation cannot in these days be alone reckoned by the number and size of its battle-ships; on the contrary, due regard must be given first to its personnel and then to the numbers and the efficiency of its rams, torpedo-vessels, torpedo-boats, torpedo-hunters, and fast scouts and cruizers. Speed—and then more speed, will be the constant cry of the seaman to enable him to make good or resist the attacks of the torpedo.

In close connection with the above, it is indelibly impressed upon our mind that far greater facilities should be afforded our naval Officers and seamen of becoming expert in the use of the ram and the torpedo. The art of manœuvring a vessel in all its bearings on the accomplished use of these weapons should form a large portion of both the theoretical and practical knowledge that we seek to impart to our young Officers, and it should form an important item in all their tests and examinations.

We believe that automobile controllable torpedoes are destined to take a large place in the future defence of ports and harbours; if so, and they be found successful, they will be the last nail in the coffin of the monster battle-ships of to-day.

It is palpable to all of us—at least to those of us who have given any thought to the subject—that the extended employment of torpedoes and submarine mines enforces the use of electricity in a hundred ways; whether it is wished to explode the submarine mine from the shore, or to discharge the heavy gun or the Whitehead from the ship,

fired perhaps by an Officer placed aloft in the top well above the smoke of the battle, in each and every case it must be done by electricity; to leave unsaid the manifold advantages of electric lighting and electric telegraphy in future naval wars would be unpardonable; hence it is most urgent that practical electricity should take a foremost place among those manifold studies that are necessary to the naval Officer.

Truly remarkable is it how all our ideas and reflections in regard to the changed conditions of naval warfare go, one and all, to prove that the naval Officer of our time must be amongst the most highly educated of men; we find that any one of the various studies and numerous subjects that are forced upon him are usually regarded as quite sufficient in themselves to form the entire profession of another man; and with all this our naval Officer has to acquire much of his knowledge under circumstances that are highly prejudicial to severe study. If this were sufficiently recognized, we think that further efforts would be made to relieve the embryo naval Officer from devoting so much time to those professional subjects which are rapidly becoming obsolete—and there are many—and so give him a better chance of acquiring that which is an actual necessity to him. We must also more fully recognize than we now do that these are the days of specialists, and so not expect our naval Officers to be, every one of them, perfect all round in the scientific branches of their profession, but giving certain men, who exhibit well-marked aptitude for special branches, every opportunity to perfect themselves in them, perhaps to the partial exclusion of some others.

We think that it is proved beyond all controversy that the necessity exists for having in these days special ships for special purposes, and further proved that the old-fashioned plan of having all vessels built on one model, but of differing sizes, and proportionately varying gun armaments, has gone never again to return; even so, specially trained Officers and men are now wanted for special ships and special purposes, and for which, if they are to be successful, they must have previously undergone a severe and preponderating course of professional training.

It will be no fault of the Officers themselves if they do not obtain such knowledge; there is, we are sure, a far greater tendency on their part to apply themselves to the acquisition of anything that is novel in their profession than there is readiness on the part of our rulers to grant the funds which are necessary to assist them in its acquirement.

Conclusion.

To us it is curious at all times to observe the vehemence with which our political free trade partizans deprecate a tax upon imported corn, strongly protesting at every opportunity against the imposition of what would be merely a nominal tax on any of our food supplies. They even go so far as to advocate that if necessary it is better that our farmers should face ruin, and that our agricultural population should from lack of work be driven into the workhouse or else to

emigration, anything in fact, so long as the manufacturing masses of our countrymen are enabled to buy a cheap loaf. Now it is no part of our essay either to laud or condemn such a policy, and we have not the slightest intention of doing either the one or the other, but all the same it is well within the scope of our efforts to point a moral from the earnestness of their contentions; to do so we would merely ask whether our consistent free trade advocates, or their political opponents the fair traders, have ever seriously concerned themselves as to what the price of wheat would be in England if our fleets were vanquished and our great trade routes even momentarily interrupted?

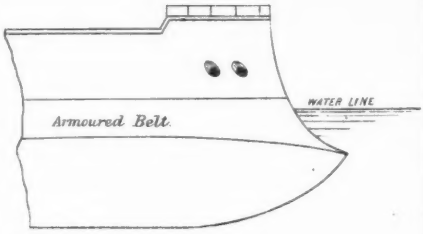
Do they rely on the Declaration of Paris, or on any special treaties of commerce? If so, we ask again, have they any good reason for doing so?

Only quite recently the French declared rice to be contraband of war: what is to prevent wheat from being similarly proclaimed, if the stern necessities of war, which knows no bounds and can be restrained by no treaty, should ever require it? What a direful prospect this opens up for our beloved country! There is positively only one remedy short of universal peace and the millennium, and that is, that England, as we know her, must at all costs and at any present sacrifice determine to retain the command of the seas.

We have done our best to demonstrate that the solid basis of good seamanship incidental to the skilful management of vessels under canvas, by reason of which our naval supremacy was established, has been cut from under our feet, and we have endeavoured to point out the exceeding uncertainty that must attend future naval wars, owing to the general employment of the ram, the torpedo, and the submarine mine, as well as to the departed omnipotence of the line-of-battle ship, under whose sheltering bulwarks our country has acquired so many glories and inherited such vast prosperity. To meet this uncertainty as far as possible on the safe side, it is more than ever necessary that Great Britain should at all times possess an adequate war fleet, manned by a highly-trained personnel, well equipped and ready at any moment to take up, on the very outbreak of war, all the arduous duties that would be imposed upon them. We cannot, alas! say that at present our fleet is in this satisfactory condition. But ready or not ready, adequate fleet or inadequate fleet, let those of us who love our country, and who are proud of her glorious history, being still hopeful of the destinies of our race, one and all in Her Majesty's Royal Navy, remember the last and most memorable signal of our greatest naval leader, and be prepared to do our duty.

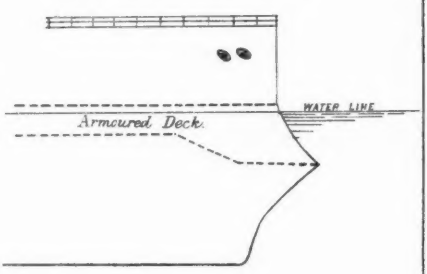
Nº I.

THE RAM, FRENCH TYPE.



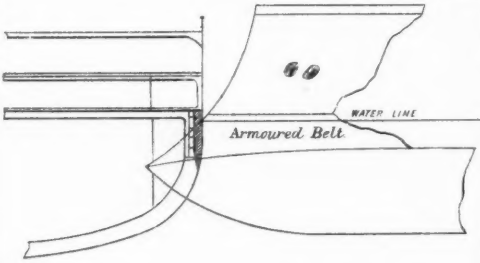
Nº II.

THE RAM, ENGLISH TYPE.

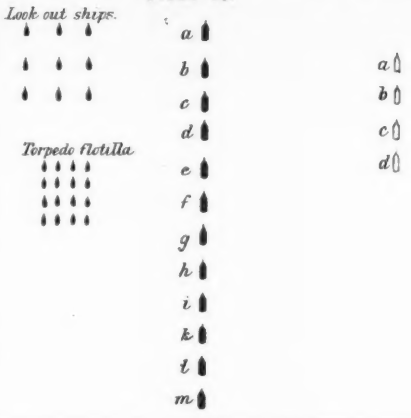


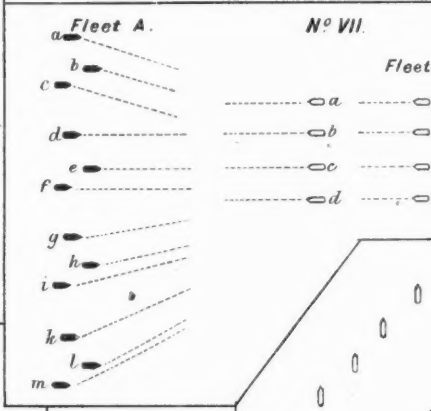
Nº III.

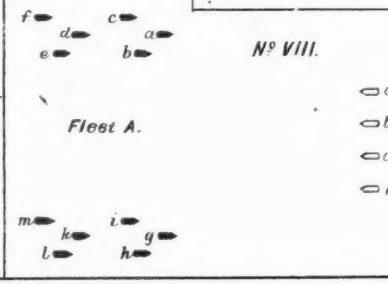
MIDSHIP SECTION, PIERCED BY RAM.

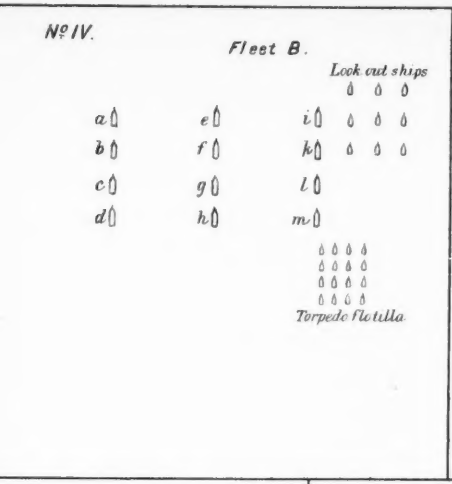


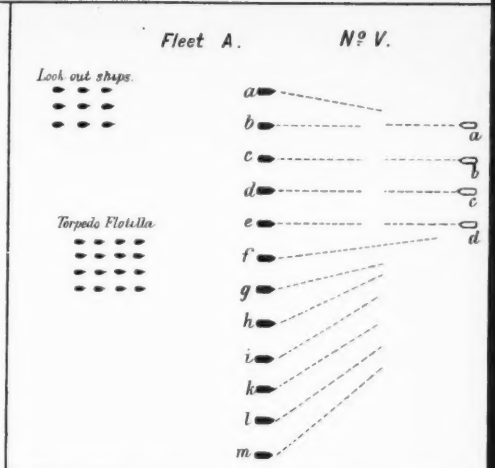
Nº IV.

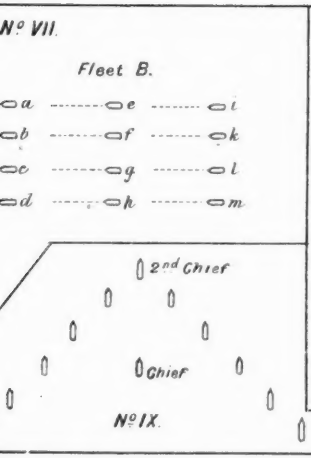


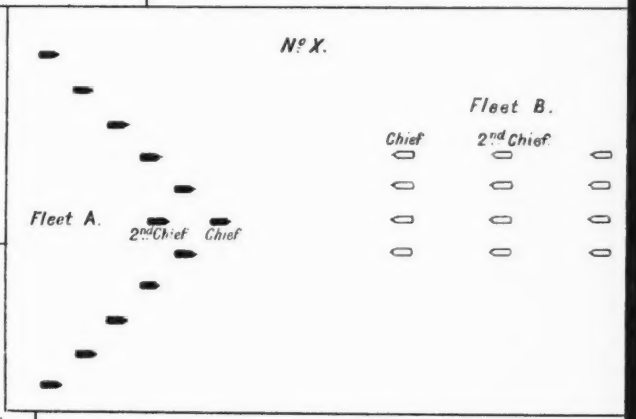


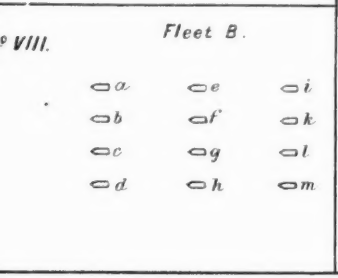


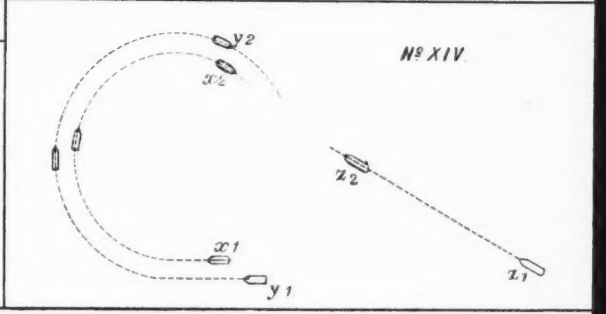












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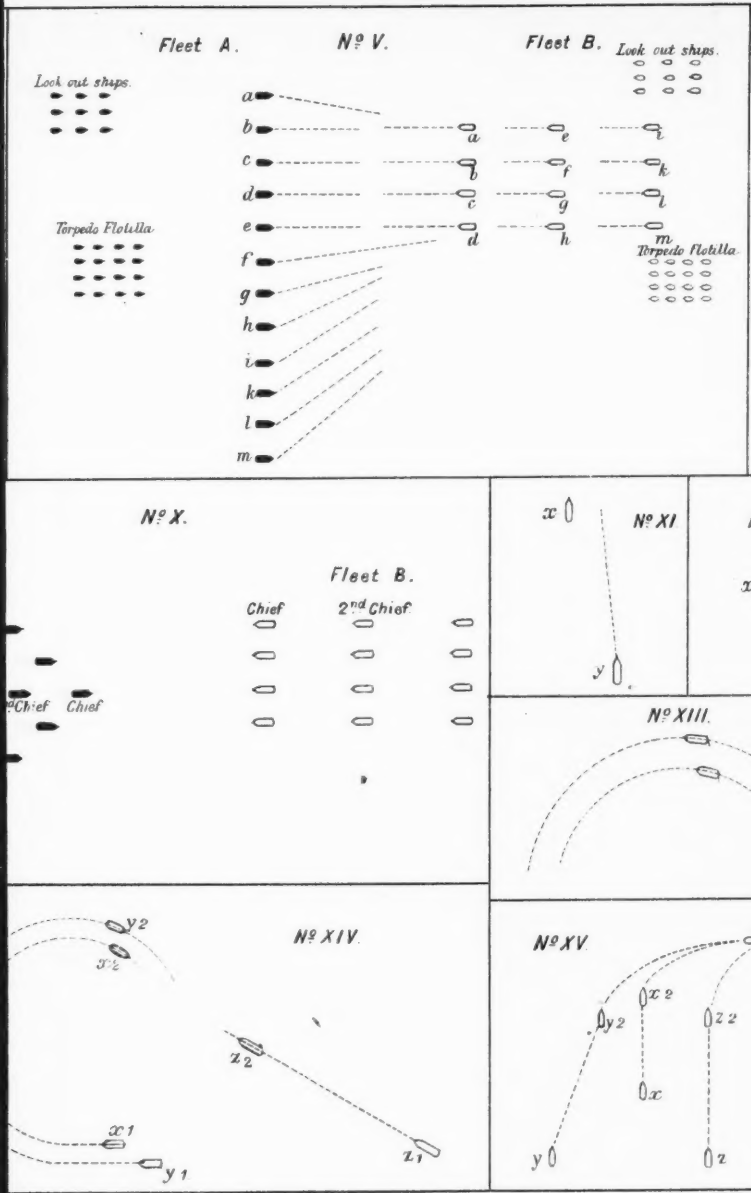

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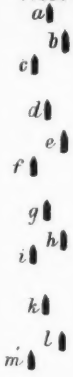
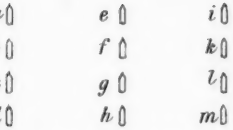
Nº VI.

Fleet A.



Fleet B.



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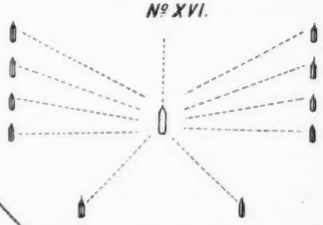
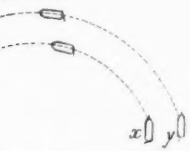
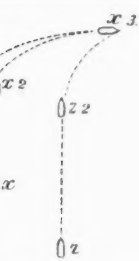


Nº XI

Nº XII.

Nº XIII.

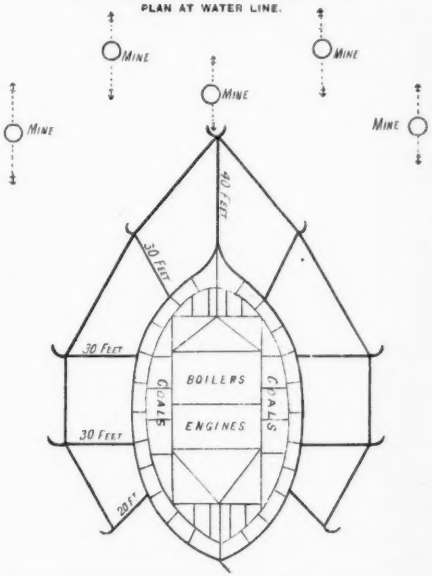




Nº XVII.

ROUGH DRAWING OF PROPOSED SUBMARINE MINE REMOVER.

PLAN AT WATER LINE.



Friday, March 19, 1886.

General J. T. WALKER, C.B., F.R.S., &c., Member of Council, in the Chair.

THE WELDON RANGE-FINDER.

By Colonel J. B. Richardson, R.A.

Until the fire of infantry and artillery approached something like accuracy, instruments which would indicate with precision and speed the distance of the object aimed at were unnecessary. For some years past the artillery, however, have been aware of the immense increase both in the moral and actual results of their fire when the range is known beforehand. It is true that they can make use of trial shots, but the judgment of the unaided eye is singularly incorrect when estimating the position of even so distinct an object as the burst of a common shell at a moderate range, while the strike of rifle and machine-gun bullets is in most cases indistinguishable. As a consequence, artillery have been the first to welcome each advance in range-finding, and the earliest steps towards supplying the want felt came from that branch. The range-finders first introduced into the Service were the inventions of two artillery Officers, Nolan and Watkin, and these still remain Service instruments.

Infantry were trained mainly to shoot at targets on well-measured and marked ranges, and as a consequence did not so soon recognize the want of an accurate range-measurer as did the artillery, whose batteries, especially in India, seldom used targets on measured ranges, and more frequently practised at gun-pits, shelter-trenches, and dummies at unknown ranges. The development of field-firing has, however, led to the demand for a trustworthy and handy range-finder for infantry, and the new Service instrument which I bring before you to-day comes from the infantry. It was the want of a range-measurer adapted to the wants of his branch of the Service that primarily induced Colonel Weldon to turn his attention and ingenuity to the invention of a variety of instruments which have resulted in the simple range-finder before you, which is excellently adapted for the field work of both artillery and infantry. While simple, rapid, and accurate in working, it is capable of standing the very severe tests of varying climates, and of the rough usage inseparable, at any rate with mounted corps, from the use of a range-finder in the field.

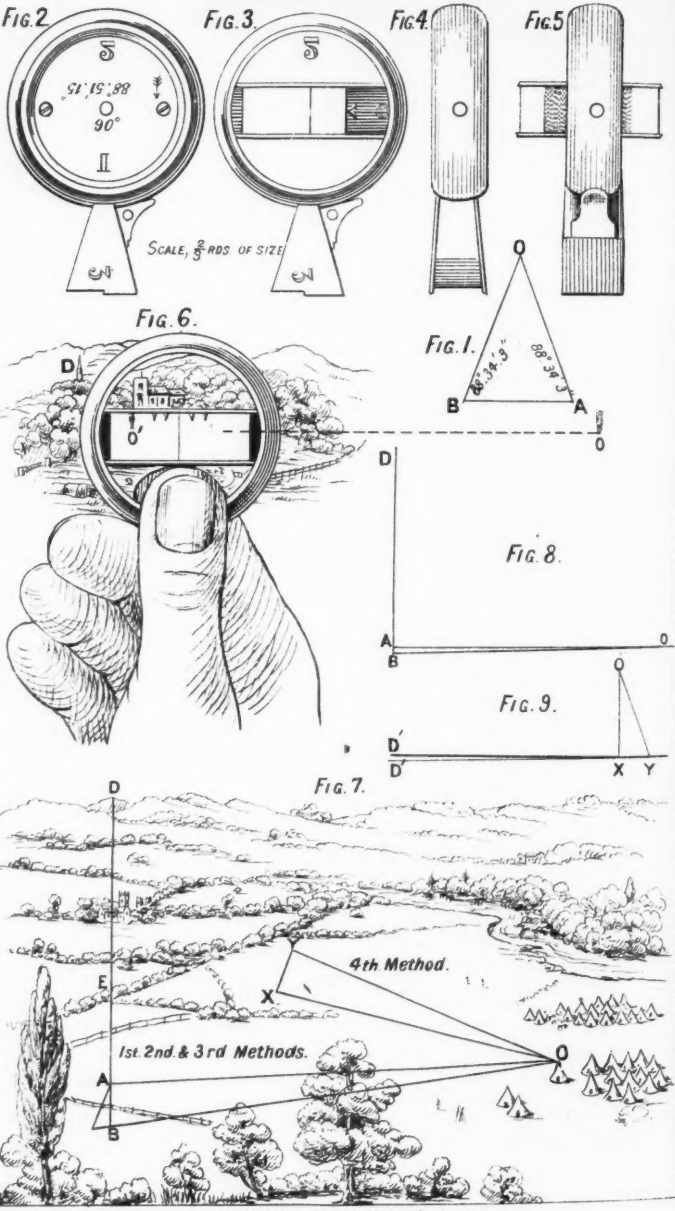
An early form in which Colonel Weldon brought forward his range-finder deserves passing notice. It was something in the nature of an optical square, the glasses, however, being set at an inclination to reflect an angle of 88° 34′ 3″. The instruments were remarkably accurate, easy to use, and possessed the desirable capacity of finding the range of moving objects with very considerable precision; the distance of the puff of smoke from a rifle was fairly accurately told by their use. There were many methods of using them, but the general system can be easily understood by a reference to Fig. 1, where an observer A, moving to his right or left, reflected the object O on B; the angle OAB = 88° 34′ 3″. The observer B moved forward or backward on the line BA until he saw in his glass the object O reflected on A; the angle OBA being also = 88° 34′ 3″. An isosceles triangle was thus formed, of which the base was to either side as 1 : 20. The base was generally paced, which was found to yield sufficiently accurate results, but it was measured if extreme precision was required. Ranges were found by trained men with remarkable rapidity, ease, and accuracy with these instruments, and they were very portable; but, while they were void of most of the defects of the Service range-finders and were effectively used on service in Afghanistan, they possessed two defects in common which appeared to their inventor to render them imperfect, viz., they could get out of adjustment, and the glasses were affected by climate. They did not easily get out of order, but were decidedly difficult to readjust if they did.

The present Weldon range-finder combines all the advantages of these early inventions, while it is free from their defects, and possesses many merits peculiar to itself. Short of getting crushed, it cannot get out of adjustment, and the silvering difficulty has probably been overcome. Exposed to severe tests, none of the new prisms have shown signs of deterioration. Figs. 2, 3, 4, 5 are representations of the instrument in various positions: you can see that it is very portable and very simple.

It consists of three triangular prisms of a specially-made hard crown glass, entirely free from blemishes and striæ. The prisms are silvered on one side by precipitating silver from a solution on the glass, varnishing, and further protecting them with several coats of a special paint, or by a layer of copper electro deposited on silver. The prisms are cemented to the frame with a cement that is impervious to damp; but even supposing the silvering destroyed it could be removed altogether and the prisms would still reflect. The two larger prisms are cemented to a bar between two circular discs of thin metal, forming what has been termed the "prism block;" and the smaller prism is similarly fixed in the handle of the ring case, in which the prism block revolves on pivots. In addition to the cement the prisms are secured from movement by small pins. The case ring, block, &c., have been made of various metals and sizes, ordinarily they are made of brass and are browned.

Colonel Weldon had extreme difficulty in getting the prisms made with accuracy; not only must the apex angle be true, but one of the base angles must be exactly half that angle, and therein lies a

WELDON RANGE FINDER.



difficulty. Their present perfection is the result of patience, perseverance, and costly experiment. Optician after optician, both in England and on the Continent, undertook to make them accurately, but their attempts resulted in constant failure. The method now adopted is a secret.

The angles reflected by the prisms are respectively—

1st prism.....	90°
2nd „	88° 51′ 15″
3rd „	74° 53′ 15″

The first two are the angles at the base of a right-angled triangle, of which the perpendicular is to the base as 50 : 1. The third with the complement of the second (viz., 91° 8′ 45″) are angles in an obtuse-angled triangle, of which the side subtending the angle 74° 53′ 15″ is to the base as 4 : 1.

In prisms of this nature, if the apex is other than a right angle, angles of more than one dimension can be observed towards the corners of the prism. These false angles would of course lead to error, but by shutting off or blinding a portion of the prism, the false angles are eliminated, and the proper angle only can be observed. In the second and third prisms of the instrument these corners are blinded by a small plate of metal (see Fig. 3). An arrow on one of the circular discs (see Fig. 2) shows the corner of the prism, and the direction, in which an observer should look when using the second prism. In the right-angled prism all three corners are available for observation (see Fig. 5). Fig. 4 shows a position of the instrument when using the third prism. This third prism is, in my judgment, of little practical use in field range-finding. It is intended to measure the base formed by the first and second prisms, but it is very seldom indeed that a case occurs in which its employment is absolutely necessary. I think that the range-finding is more accurate without it, and as rapid; except in the instance of very long ranges, say two miles or so. However, it is not in the way, it renders the instrument complete, and its use has the very remarkable property of compensating for errors of observation of the length of base. The third prism with the second gives a triangle of which the base is to the side subtending the angle of 74° 55′ 15″ as 1 : 4.

A little practice is required to bring the image of any object to the right (or left) of an observer into the field of the prism. With the prism block turned at right angles to the case ring, the instrument is held as shown in Fig. 6, close to the eye, by which a large field is obtained, and only a slight turn of the head or hand is required to bring a fresh field into view, either laterally or vertically. The prism block is steadied by the thumb and forefinger, taking care to leave a space below the corner of the prism, so that objects seen in front by direct vision, either above or below the block, may be viewed simultaneously with objects reflected in the prism. The reflection of an object on one side of an observer is to be looked for in the corner of the prism furthest from the object; thus, the reflection of the man

at O on the observer's right is found at O′, towards the left corner of the prism, Fig. 6.

The reflection of an object in any of the prisms can be aligned on any given point seen by direct vision in front, by the observer moving to the right, left, backwards, or forwards. In range-finding, if an observer sees the reflection of O (Fig. 6) fall to his right of a point D, he can bring O immediately under D by moving to his rear if D is far away; or to his left, or diagonally to his left front, if D is near. It is practically best, however, not to try to bring the reflection on any special object seen by direct vision, but to choose a distant object on which the reflection falls true, as in this case on the church tower.

The eye of the observer forms the apex of the angle to which the prism is cut, when objects on either side of an observer appear directly underneath (or above) those seen by direct vision; but to make a correct angle the reflected object should be kept upright and the reflected horizon as level as it is naturally, for if the instrument is held so that the ground reflected appears to slope when it is really level, or *vice versâ*, the required angle will not be observed. An observer also must be careful to fix his attention on the far-off direction point, and not on any intermediate object such as a pole, &c., which he has placed as a guide to lead his eye straight to the distant point. This is often neglected at first, and leads to error. This is explained later on.

There are several methods of finding the range of a distant object with the prisms:—

First Method.—One observer using nothing but the second and first prisms in the order named. This appears exceedingly simple, but it requires a vast amount of training and practice. With unskilled observers it is unreliable.

Suppose the range of an object O (Fig. 7) is required. The observer using the second prism at B, reflects O on some distant point D. The angle OBD = 88° 51′ 15″. Selecting any intermediate object, say E, on the line BD, to assist him in walking straight, he paces towards D, stopping to observe at intervals with the first prism, until he arrives at A, where he sees O reflected along the line AD, so that the angle OAD = 90°. In moving from B to A he has counted every second pace by the simple rule of commencing with the left foot and counting a unit every time the right foot came to the ground. These units of base represent hundreds of yards of range. The greater the excess of BD over BO, the greater the chances of accuracy.

Second Method.—One observer using the first and second prisms, aided by a mark such as a pole, or a man, a sword stuck in the ground, or anything that can be left to mark a particular spot. A specially made pole is the best.

Taking the same figure (Fig. 7) with O as the point of which the range is required, the observer, using the first prism at A, reflects O on a distant point D, and plants a pole at this spot. He turns the prism block so as to have the second prism ready with the blind on the same side as the object, and retires on the line DAB. He stops to observe, facing D; perhaps seeing the reflection O on *his* right of

D. He has not gone far enough. Suppose he moves too far to the rear, he will see O on *his* left of D, and must advance; but he quickly finds the point B where O is reflected true on the line of the post at A and the distant point D. Then, as before, the base BA = $\frac{1}{50}$ OA, and may either be paced as described under the first method; measured with a tape, on which is marked hundreds and tens of yards of range; or measured by using the third prism, as described under the third method.

In either of the above methods, if a good natural direction point D cannot be found, a pole, or a man with a rifle or stick, may be placed as a direction point, care being taken to place the pole, or whatever else is used, at a distance from A proportionate to the range. Thus, if O is probably about 1,000 yards away, the pole should not be less than 50 yards; if OA be 2,000 yards, the distance point should certainly not be less than 100 yards, from A. The further the distance point the greater the chance of the range found being accurate. It rarely happens that a good natural distant direction point cannot be found on one side or the other, in country where troops are likely to want to know a range.

Third Method.—If it is thought desirable to measure the base AB (Fig. 7) found by the second method, with the third prism, another pole or marker is required. Having found A and B by using the first and second prisms, the observer plants the second pole at B, hooks to it one end of a tape on which is marked hundreds and tens of yards of range at every 18 inches, and walking back on the line OB, he arrives at a point C, where the pole at A is reflected along the line BO. Then CB = $\frac{1}{4}$AB = $\frac{1}{200}$ AO. Every hundred yards of AO is thus represented by 18 inches of BC.

This method is introduced to meet the difficulty of measuring a long base AB accurately if the ground is rough, or if obstacles intervene between A and B. Thus, supposing O to be 5 miles distant, BA would be = 170 yards, and it would probably be considerably quicker to use the third prism than to pace or measure the base, but for ordinary artillery or infantry ranges, the base AB is so short, that I think it is quicker and more satisfactory to pace or measure along the base.

Fourth Method.—This is also rapid and accurate, but needs some training. It requires two instruments and two observers, each using the second prism. It adds to the capabilities of the instruments one advantage over other systems of range-finding with which I am acquainted, viz., ease in ascertaining rapidly the range of a moving object. This, as I have said, was a point claimed for Colonel Weldon's earlier range-finders, and his latest instruments retain the advantage.

Turning to Fig. 7, suppose O to be again the object whose range is required, an observer X, using the second prism, reflects O on the second observer Y, moving either to his right or left for the purpose, but not to his front or rear. Y, also using the second prism, moves either forwards or backwards, but never to his right or left, until he gets the reflection of O true on X. Then each of the

angles OXY and OYX = 88° 51′ 15″ and XY = $\frac{1}{25}$ of XO or YO. Every 4 yards of the base paced represents 100 yards of range. In practice whenever either observer sees that he has the reflection of O truly on the other observer's instrument, he raises his disengaged hand. When both observers give this signal at the same time the base is found. By this arrangement little difficulty is experienced by trained observers in getting the base, even if O be moving with considerable rapidity. Directly the signal is simultaneous the base is paced, a few seconds sufficing. Neither observer under any conditions requires to move more than $\frac{1}{25}$ of the pace of the moving object.

Little accuracy of result will be obtained by pacing, as described in the above methods, unless an observer is trained in pacing yards. A man can be trained to do so in a very short time, but practice is necessary to keep up the attainment. A plan which has been found very successful is as follows:—200 or 300 yards are measured on some line which chances to be aligned on distinct objects, so that men may be able to march straight along it. At each hundred yards a peg is driven in to the head, so that it cannot be readily seen. For a few yards at each end of the line pegs are also driven in to a level with the ground at every yard. The man paces up and down these minor marks, until he gets an idea of a 36-inch pace, and he then paces from the starting point along the whole line. Commencing with the left foot, he counts the number of times his right foot comes to the ground, and halts when he has counted fifty. If he has paced yards correctly, and walked straight, his right foot should be on a peg, if not, the difference constitutes his error. He soon learns not only to pace yards but to march straight, and to count without effort the number of hundred yards in a range formed by the first and second methods. For the fourth method his counting should run 1.2.3 **1**; 1.2.3. **2**; 1.2.3. **3**; counting each pace, and his right foot would be on a peg when he has counted 25.

It has been objected that the base used in the first and second methods is too small for accurate results. Fig. 8 is a figure drawn to scale.

It is impossible for the eye to distinguish the exact point where the lines AO and BO cut one another about O. A base of 1 : 50 appears altogether too small to measure such an apex angle as AOB, and so it would be if the base were found by measurement of two interior angles. It is the attempt to measure the interior base angles of a small based triangle that proves the greatest source of error in most systems of range-finding. When the distance is too short between the eye and the other end of the base, the least lateral movement of either sensibly affects the result. This is easily demonstrated by the following diagram.

Suppose two lines D′Y DY inclined to one another at a small angle. For a considerable distance they appear to run in one line, but the eye detects divergence at X and Y. With XY as a base erect a triangle XOY, and suppose the apex O to be an object of which the range is being taken. The observer at Y in measuring the angle

OYX may be observing either of the angles OYD or OYD′, and similarly, if his eye has no further than Y to travel, may observe false angles when measuring OXY. The greater the distance of D and D′ from Y, the more easy is the error detected. Lateral error, in fact, creeps in with greater or less ease, according as the base XY is shorter or longer.

Weldon avoids this source of error in a very simple manner by observing one interior and one exterior angle, so that for range-finding purposes his base is from the eye to the far off direction point, which is possibly 10 miles away. Thus in Fig. 9 he uses the angles OYD, OXD′. It is this which enables a simple instrument, devoid of telescopes or other complicated aids to the eye, to obtain such correct results.

Colonel Weldon has some Wollaston's prisms, giving the required angles of reflection, in which light is totally reflected within the prism. Silvering is here unnecessary, and instruments so made are absolutely free from the influence of climate.

The time at my disposal will not allow me to do more than state the general results of official trials of the range-finder. All reports that I have seen have been, with one exception, highly favourable. In nearly all cases it appears to have been tested against Watkin's range-finder, and generally by observers practised in the use of the latter, but to whom the Weldon was a novelty, and who in some instances used it for the first time at the trials. The fact that under these circumstances remarkable accuracy was generally obtained is perhaps the highest testimonial to the efficiency and simplicity of the system. The exception mentioned above was a report from Bombay, which, though on the whole favourable, stated that the Watkin range-finder proved in most instances the most accurate at very long distances; there were no serious discrepancies between them, and it was further remarked that had the observers had as much practice with the Weldon as with the Watkin, the results might have been different. Few of the reports take the time occupied in finding a range into account, yet the great rapidity with which distances can be measured with the Weldon is, combined with its general accuracy, one of its strongest recommendations as a field range-finder.

The chief points urged in favour of the Weldon system in the various reports are:—1st. That it is easy to learn and teach its use. 2nd. Not liable to get out of order. 3rd. Practically accurate. 4th. Compact. 5th. Portable. 6th. Light. 7th. Cannot get out of adjustment. 8th. Serviceable in the field. 9th. When mean of two observers is taken ranges found are as near as possible correct. The only objections I have seen in the reports are:—1. That it is difficult to obtain coincidences in a bad light, or in a very bright light. 2nd. That there is a glare from the metal case, and that the case should be of dull metal. 3. That there is a difficulty of obtaining coincidences, owing to the thickness of metal of prism block.

With regard to the latter, the metal of the prism block is now made very thin. It would be a decided advantage if it could be done away with altogether. The first objection is common to all

range-finders. The second is easily got over by shading the instrument with the disengaged hand.

The most exhaustive, and probably the most accurate, official trials in England were those made at Aldershot. I have not had access to the original papers, but I believe that the following figures are correct as to one series of observations:—

Number of observations.	Ranges measured on O.S. map. Yards.	Weldon. — Error in yards.	Watkin. — Error in yards.	Error per cent. of range.	
				Weldon.	Watkin.
100	183,015	3,390	7,342	1·8	4·0

and it is curious that a long series of official trials in India gave very similar results.

One remarkable observation occurs in the report of trials at Bangalore.

Distance observed by Weldon R.F.....	14,350	yards.
„ accurately measured by theodolite	14,400	„
Error	90	„

The distance is over 8 miles.

In some of the Indian trials the average time taken in obtaining measurements of ordinary ranges is given as $1\frac{1}{4}$ minutes. I have myself seen many correct ranges taken in less that 1 minute each, and the distance of moving objects very approximately given in from 35 seconds to 50 seconds, by well-trained observers.

Major A. FEATHERSTONHAUGH, R.E.: When I was in India I saw some observations taken with Colonel Weldon's instrument, and I also saw another instrument used, which was really a modification of the Weldon instrument by Mr. Bolton. It was very much on the same principle. The original base adopted by Colonel Weldon was one-twentieth. There was an official trial made of the Bolton instrument, which, as I said, is very much the same as Colonel Weldon's, before the Commander-in-Chief in Calcutta, and although no opinion was then expressed, the difficulty in the minds of those who had to judge of the subject was that the base was too long. It was only one-fortieth, but it seemed to be very long. It has now been reduced to one-fiftieth, but that is still very long, being 20 yards per 1,000 yards. 1,000 yards is not a very long range now-a-days for artillery purposes, but if you are on the top of a hill, such as you get in Afghanistan, it is very difficult indeed to get 20 yards straight on end in every direction. I should be glad, therefore, if Colonel Richardson could answer that question as to whether even 20 yards per 1,000 is not rather long. My second remark is upon the fourth method of observation, which Colonel Richardson says he finds useful in taking the distance of moving objects. You have two men, one at Y and one at X, taking the distance of the object at O, and that object is supposed to be moving at 5 or 6 miles an hour, or more. If it is a steamer it would be going 10 or 12 miles an hour. These two men have to take

two observations of this moving object, and to manage so that their observations are simultaneous. I should like to ask how is that possible, seeing that they have no communication with each other? How can they arrange to get their observations absolutely simultaneously? It is just as if two men were firing at a partridge, one holding the gun and the other pulling the trigger. I think, therefore, there must be something that is not quite clear about this finding the distance of moving objects by the observations of two men. The only other thing that I would refer to is the last paragraph of the lecture, in which Colonel Richardson mentions a series of observations taken at Aldershot, and out of 100 observations he gives the error per cent. of range with the Weldon instrument as being 1·8. That I suppose is the mean. Those who have had to deal with astronomical observations know that provided there is no radical error in the process you may get a mean of any accuracy you wish by multiplying your observations, because although one observation may be a large distance wrong in one direction, the next observation may show the same error in the other direction, and the result is you get a mean error of a very small amount, whereas the error of a single observation may be very large indeed. It seems to me that for military purposes your first observation should be as accurate as possible, and it is no good saying that twenty other observations taken immediately afterwards would give a small mean error.

Major WHITE: In rising to speak on this subject I may state that I do not come forward in any official capacity. I am, however, instructor in field range-finding to the mounted branches of the Royal Artillery, and at present in charge of the School of Range-finding at Aldershot, and I was Secretary to the Committee on Range-finders from 1879 to 1881, so that I have some experience in these matters. Now, I think, that too much attention is paid to the range-finder and too little to range-finding. It is as if the whole of a discussion on musketry were to be devoted to the particular rifle used, and not to the shooting. A great deal depends on the way in which an investigation of this kind is conducted, for while no doubt various instruments have various merits, one is often better than another for a particular purpose. Colonel Richardson has brought forward this range-finder as an infantry instrument, and therefore I cannot say so much about it. The infantry know their own requirements best. Of course an individual soldier does not take the range to each opponent he aims at; but no doubt in the field if you got a large body of infantry or cavalry *stationary*, and you wanted to fire at a long distance which you could not measure by the eye, then the aid of the range-finder might be important, and in that case an instrument which gave *approximate* accuracy *with rapidity* would undoubtedly have a great advantage over one which gave the greatest accuracy but with some loss of time. I have myself carried out a number of trials with the Weldon range-finder, and with instruments identical in principle,[1] and I have seen the reports of other trials. The result I find is that it will take the range with approximate accuracy and considerable rapidity. I do not know the exact comparison, but it will take it quicker than the Watkin range-finder, because a much shorter base is used. The time occupied in taking the range with the Watkin range-finder is that taken up in running over the base and back again by the range-taker in addition to the time needed for the two observations, which you may say is one minute for a long range, and half a minute for a short one; thus with the Watkin range-finder up to 1,000 yards we allow two minutes per range, and as we increase the ranges we increase the bases, and therefore the time, until when we get to 6,000 or 7,000 yards we allow as much as six minutes per range; but of course very long ranges would only be taken for artillery purposes, and under circumstances in which spending five minutes or even a quarter of an hour more or less would not very much matter. It would be the case of engaging an enemy which had fixed positions at great distances, and where it was of the greatest importance to get an accurate range within 100 yards or less. With regard to the Weldon range-finder, it undoubtedly finds the range quickly if it finds it at all, but it has the disadvantage that there are many places where it is altogether inapplicable. You are tied down to a certain base, and you may find that

[1] Mr. Erskine Scott's range-finder; the Steiner range-finder; the Edwards range-finding system.

it lands you in a pit, or a hedge, or the middle of a wood, or it runs you down the side of a hill, and you cannot see the auxiliary object that you have to line yourself on. What you want is to be able to put down a marker at any point and take the range from *that* point; it is no good finding the range from somewhere else when time is an object; that may be very useful, but you have to consider the time lost in making the correction. That is a disadvantage constantly met with when you are dealing with lumpy ground—I won't say hilly ground—because you may get very good ground for the Weldon instrument in a hilly country; you may get slopes giving you plenty of base; you may see your object in whatever direction you go, and you may get distinct auxiliary points. It is, however, a very great tie to be compelled not only to see your distant object from your own pickets at each end of your base, but also to find something to your right or left to work upon. There are many cases where you cannot find the range on account of the proportional base. You think you are going to get it, but a house comes in the way or a tree, or something just at the point where you ought to make your second coincidence, and then you have to begin *de novo*. I think on the whole, however, that these instruments may be made very useful, and we are very much indebted to Colonel Weldon for what he has done so far. There was no doubt a difficulty at first in getting the prisms properly cut, but the Service specification allows a liberal margin for their accuracy; it actually allows two different instruments to have a plus or minus error of 2½ per cent., that is, a difference between them which would amount to 5 per cent. difference of range (5 yards per 100 yards), though the variation would rarely of course come up to that. That is the Weldon. The first Watkin instruments were given to the regiments for use, but the men were not shown how to use them. The result was they broke them very quickly. It was very much as if you had started a telegraph, and sent your instruments and wires down to various regiments, and said, "There, that is a nice telegraphic apparatus; let Tommy Atkins use it." The result would be, no doubt, that he would break it. It was the same with these range-finders, and I am not at all surprised that they could not take a range. But now-a-days we have established a school of range-finding. We take our non-commissioned officers of Horse and Field Artillery and put them through a very severe course of training. If, at the examination, their average work shows inaccuracy exceeding 4 per cent. in the range, they do not get a certificate. If it is better than that, they are marked "good," and if the error is less than 2 per cent., they get "very good;" and out of a class of about twenty, there are often two, sometimes three or more, who get "very good."[1] So much for the Watkin. It is a very good instrument, and there is not much fault to be found with it. Nevertheless, you can get approximate accuracy with greater rapidity sometimes if you use the Weldon, and for infantry purposes they want very rapid methods without much trouble in learning. With regard to the use of the instrument, however, there is one great difficulty. You *must* hold it in the plane of the objects, and this is not an easy thing to do when they are not in the *horizontal* plane. The result of our first trials at Aldershot was this:—They showed that if men were well trained they could use the Weldon instrument very well, but that they required even more intelligence and training to use the Weldon *properly* than to use the Watkin. That of course is easy to understand, although if you give the Weldon instrument to a man who has never seen it before, you can teach him in an hour or two how it is to be used. For instance, Officers have come to me, and I have soon taught them how to use the instrument, but they have not always seen that they would want months of practice with it in order to take ranges accurately. With the Watkin instrument they would not be able to take a range after, say, only half an hour's instruction, but with proper training the use of the Watkin instru-

[1] 1885. Class of 21 non-commissioned officers—6 very good.
12 good.
3 failed.
" 16 " " " 3 very good.
10 good.
3 failed.
" 7 " " " 6 very good.
1 good.

ment becomes mechanical, and it tells its own tale. Colonel Richardson says, "It rarely happens that a good natural distant direction point cannot be found on one side or the other." At the camp at Hay last year I attended the artillery practice that was carried out with range-finders, and I know that in *many positions* we could not possibly have found a good distant point. It is really very hard to find. With reference to the fourth method of working, mentioned by Colonel Richardson, I quite agree with Major Featherstonhaugh that you must not employ two observers. In all range-finding you have to observe *a point*. Now, if you see a body of infantry you may say, "Take *that Officer* as your point." Oh, yes, but *that Officer* is a different one in the estimate of No. 1 and No. 2, and the chances are that your second observer takes the wrong man. And then even taking to a man, say, a cavalry soldier, you must have an idea whether you are taking to his head or to his horse's nose. In this way, too, observers make terrible errors. We never allow a second observer with the Watkin instrument on this account, although we should save time immensely by doing so. Generally speaking, you have to take such objects as rifle-pits, shelter-trenches, and so on, often some little lump of ground which is very difficult to see, and which you cannot possibly explain to another man. I think, therefore, that the fourth method does not answer. With regard to length of base, there we come on to ordinary scientific ground. Apply it in any way you like, the human eye, unassisted by a telescope, cannot appreciate a difference of angle of less than about one *minute*. If you take a triangle and solve it, you will find that if you make an error of one minute in each base angle, whether you measure the exterior or interior angles, you make an error of something like 3 per cent. in the range, when the base is about one-fiftieth the sides, unless the errors happen to be in the right direction for correcting each other. You get very much less error in range as you get longer bases. Colonel Richardson has quoted the Aldershot trials to show that the Weldon range-finder is superior to the Watkin in accuracy. Now there were some inconclusive trials in 1883 when some damaged Watkin instruments were compared with some new Weldon range-finders, but even then the results reported do not appear to agree with Colonel Richardson's figures. I have in my hand my own report of the second trials at Aldershot in 1884 under my supervision. These are the results :—

	Error per cent. of range.	
	Weldon.	Watkin.
1,000 to 2,000	5·8	0·75
2,000 „ 3,500	4·97	1·00

The Weldon was rather better at the longer ranges compared to itself, but the error was nearly five times as much as with the Watkin. The errors, however, were not very great. The Weldon only made an error of 50 in 1,000 yards.[1]

[1] In the trial referred to there were three observers, and about 400 observations were taken with two Weldon range-finders ; they were used—

1. Without equipment ; men as markers and the bases paced.
2. With pickets, but all bases paced.
3. With pickets and the bases measured.

One instrument read from 1 to 2 per cent. better than the other. The *best* gave the following figures :—

Mean Errors per Cent. of Range.

1st. Without equipment.		2nd. Pickets only.		3rd. Pickets and tape.	
1st and 2nd prisms.	3rd prism.	1st and 2nd prisms.	3rd prism.	1st and 2nd prisms.	3rd prism.
7·61	10·11	6·15	7·80	5·57	6·76

Major-General DRAYSON: I wish, Sir, to take up the history of this instrument a little earlier than I think Colonel Richardson has mentioned. In the year 1864 I had a great deal to do with range-finding, and the introduction of range-finding into the artillery. I found when I had non-commissioned officers to deal with, that the difficulty of their reading the vernier was so great that I used the Hadley sextant clamped at particular angles, so that they could not by any means alter the vernier; the angles I selected were 84·17, which gives a range ten times the base, 87·8 which gives 20 times, and 88·33 the same as Colonel Weldon has used. After a time I thought it would be much more simple to get an instrument made by Messrs. Troughton and Sims, on exactly the same principle as a Weldon, with the exception that I used glasses instead of a prism. These glasses gave an angle of 87·8, and a range twenty times the base. I was very much attracted by this instrument at first, and several old Officers of artillery, who had forgotten how to use the vernier, were delighted with it. As long as I was on Woolwich Common I could get my range admirably. There was a fine open space, and when we compared the distances with the Ordnance map, we found the results very accurate. But as soon as I got into the country, the difficulty mentioned by the last speaker occurred. I wanted a base one-thirtieth or one-twentieth of my range, and when I walked back to get it I got into a hedge, or a sand-pit, or something of that kind, and I could not get my range. I had to get the other man to move further off, and then he would say he could not get any further. The result was we gave up this system, in consequence of the base always necessarily being a certain proportion of that range; this, I think, is a defect in any range-finder. If you get a fine open level space where you can see distant objects, and see the second man, there is nothing better than the system I adopted. I am somewhat surprised to hear from Colonel Richardson that he seemed to think the first experiments made by Colonel Weldon were original. They are identically the same as mine made nearly twenty years before. Now I gave a lecture at the Indian United Service Institution, at Simla, in 1876, at which there were several distinguished Officers present, and amongst them Sir Frederick Roberts and Sir Peter Lumsden. Sir Peter Lumsden was so taken with the instrument that he suggested it should be supplied to the different garrison instructors in India. I told him I thought it would be no good, and that I did not recommend it. Some years after that Colonel Weldon produced his instrument, which is precisely similar to this, and I think it at least singular that he should claim it as his invention. I can answer one point raised by the first speaker, namely, that with this and a second instrument we can

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The same ranges were taken with two Watkin range-finders, the average mean error per cent. of range being 1·08. That this is not an exceptional figure is proved by the results of the range-finding at Hay in 1885 by the range-takers of the batteries which practised there in succession, and which are marked in the columns as 1, 2, 3, &c.

	1.	2.	3.	4.	5.	6.	Remarks.
Number of observations	6	8	7	8	7	16	
Greatest error in each series, per cent. of range ..	3·9	7·0	2·5	2·4	3·3	3·3	The range-taker of the seventh battery in camp was absent.
Longest and shortest range taken	1,906 800	2,896 1,400	4,050 1,605	2,896 800	2,896 610	2,896 1,400	
Average error per cent. of range ..	1·5	2·9	1·0	0·96	1·4	1·7	

take ranges of moving objects as simply and exactly as we can objects not moving. It is not the case of one man holding the gun and the other pulling the trigger. One man stands with this instrument in his hand, and it is his business to keep the second man and the distant object in coincidence, and he does that by moving backwards and forwards; he keeps on doing it, and he has tremendous power of doing it, because if the base is only one-twentieth of the range, he need only move at one-twentieth of the speed of the distant object, so that he can actually keep a railway train in coincidence. The second man does the same thing, it is his business to move a little further off, or to come closer in; there is no difficulty whatever. I have taken steamers at Portsmouth and on the Thames, and at intervals of half-a-minute I have given what the range has been. One other point, I think, is very essential: it has been mentioned by Major White, namely, that you not only have to train your range-finders with the greatest care, but in addition to that you have to keep them in practice. Not long ago, when I was at Halifax, in Nova Scotia, we got some men who had first class certificates for having found ranges with the Watkin range-finder. The first thing that those non-commissioned officers said to me when I asked them to take a range was: "We have not used this instrument for two or three months; we are quite out of practice;" and they were so much out of practice that they could not get the range at all. I think the essential defect of any range-finder is where you have no mobility of angle and base, for if you are fixed to a particular base you will be running foul of objects just at the time you want to get your range, and so you may lose your opportunity and the time will be passed for the range being of any service at all.

Captain C. B. MAYNE, R.E.: I would like to say a few words, Sir, on behalf of the infantry, although I am myself an engineer. In the first place, the conditions of using range-finders for infantry and artillery are very different. The artillery often have to fight at very long distances, and in all cases want their range exactly, but under conditions which, in a large amount of cases, are different from those for infantry. It is a curious fact in infantry fire that when the men all fire with the same elevation, then from 500 yards and upwards, the mass of the bullets, or rather the best or inner 50 per cent. of them, fall fairly evenly over 100 yards; this fact should be borne in mind in constructing infantry range-finders, and it is upon this fact also that all the rules of firing on the Continent are based, especially with regard to judging distances by the eye. Abroad they say the average error of judging distances is one-eighth the estimated distance; but this may be under or over the range, so that the total error to be allowed for is one-fourth the estimated range. Up to 400 yards the total error of judging the range is under 100 yards (the length of the spread of the bullets), and consequently there is no necessity to use more than one elevation up to 400 yards, especially as the bullet remains under the height of a man up to that range if aim is taken as his feet. Up to 800 yards the total error to be allowed for of one-fourth is 200 yards, and therefore we must divide the men firing, and make one-half of them use a sight for 50 yards over, and the other half a sight for 50 yards under the estimated distance, so that their bullets will spread over 200 yards, and then cover the ground on which the objective stands, in that way. The same method can be used up to 1,200 yards, but there we must use three sights, one for the estimated range, one for 100 yards over it, and one for 100 yards under it, so as to cover 300 yards of ground with bullets. But that means a great expenditure of ammunition, and it seems that we can only really get the greatest efficacy for infantry firing that can be obtained by the use of a range-finder, which will give the range to within 50 yards up to 1,500 yards, the maximum range for infantry fire in the field.[1] Supposing we are in a defensive

[1] Perhaps this is a very severe condition, and a more just one would be to give the range within 100 yards up to 1,500 yards, and to within 50 yards up to 1,000 yards, which would require the use of one sight only up to 1,000 yards only, and two sights only up to 1,500 yards. This would suit the organization of our smaller units, as a use of three sights would find considerable difficulty in our ranks, unless we devote three whole companies for the purpose, because it is laid down in Germany that when three sights are used, a whole company (250 men) should be employed, and the German company is organized in 3 *züge*. When two sights are used they say

position, and the enemy has not arrived. Of course under such circumstances any range-finder can be used, and distances can even be measured if necessary. For the former purpose, I think one of the simplest range-finders is the plane-table. One advantage of this instrument is that with the same base one can find the range of any number of objects in different directions, whereas with all other range-finders, the Weldon, the Watkin, and so on, for each object (if they are not all in one line) one has to take a different direction of base, which is a very serious objection, especially when one is on a ridge, as would be the case for troops in a defensive position, because if the further end of your base lies over the ridge you cannot see the distant object to find its range. With the plane-table you can take a great number of ranges in any direction from the same base, and if it is done on a sufficiently large scale, and with a sufficiently large base, very accurate results can be got. But in action, when the "music" has begun, and we are acting on the offensive, I should like to see anybody trying to use any of these range-finders, having to move, as they would have to do, up and down the firing-line, in order to take a range in the midst of all the smoke which is hanging about both in front of the defensive line, observing the objective whose range is required, and in front of the attacking troops, making the light misty and dim. For such purposes, I think, that any range-finder for the infantry should not have a base longer than the length of a rifle, or of an Officer's sword. All the range-finders at present before the public are admirably adapted for the artillery, who are stationary and have ample time and everything else in their favour for using them, but for infantry who are moving, I think that any range-finder that requires a base longer than a rifle or a sword, as the case may be, or has an error greater than 50 yards up to say 1,000 yards as a minimum, is not of any value to infantry; I do not see how they are going to use it under fire. There are some range-finders that I have tried that allow of a small choice of direction in the base; one is a very small and handy range-finder called the Labbez, which allows about 5 degrees in choosing the direction of the base. I have also tried the "Bate" instrument, made by Messrs. Elliott Brothers, which is a new one, and can be attached to one's field-glasses, and also one latterly introduced by Mr. Steward, both of which allow of about 30 degrees choice in the direction of the base, and they all three employ the principle which Colonel Richardson pointed out, of measuring one exterior and one interior angle instead of two interior angles as is done by the Watkin. They all have given very fair results as compared with the Watkin. This choice of direction in the base line is one thing the Weldon does not give, nor does the Watkin.

Admiral BOYS: Might I ask the cost of one of these Weldon instruments?

The CHAIRMAN: I don't think it is very much.

Colonel RICHARDSON: 1*l.* per prism; 3*l.* in all. In reply, I really seem to have very little to reply to, for most of the remarks have been made on other range-finders. Major Featherstonhaugh referred to the "Bolton." I can tell you that the Bolton range-finder was brought out after a lecture which I gave at Simla on the original Weldon instrument, and I heard from Mr. Bolton that it was nothing but the Weldon instrument over again.

Major FEATHERSTONHAUGH: I explained that; I said that they were practically the same thing.

Colonel RICHARDSON: Major Featherstonhaugh also said that the base was too long, and in particular that for mountain ranges it is too long. I have not had the opportunity of trying the new instrument on mountains, but it has a very much shorter base than the old one, which I tried a great deal in the Himalayas on the worst ground possible. I saw artillery practice carried on there with the aid of these range-finders with most excellent results. I am talking of the old Weldon range-finder. The mountain batteries adopted it, because it was the only range-finder that would find a range on such hills. With regard to moving objects the

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that a whole *zug* or eighty men (that is to say about an English company) should fire to obtain a good result. Two sights could easily be used by us but not three sights, and any instrument which will enable us to make use of two sights only up to the extreme range of infantry fire should be eagerly sought after. Mr. Mallock's instrument seems to offer such an one.—C. B. M.

difficulty has been explained away by two other speakers, who have answered that question entirely, and in fact there is no difficulty whatever in finding the approximate distance of a moving object.

Major FEATHERSTONHAUGH: How do you know whether you are right?

Colonel RICHARDSON: We used to send a man out galloping. I had a signaller by me, and the mounted man was ordered to stop the instant a large flag or ball was raised. He was set galloping, and on the range-finders both saying "Right," which they did when each had the reflection of the man true on the other, the man was halted by the signal; he might perhaps move five or six yards after the signal was given, if he was trotting or walking, but when he was galloping, it was a little difficult to stop him, though he halted as soon as possible. The range was sometimes chained up to him, or it was sometimes taken using him as a standing object, or sometimes he planted a pole, so as to mark the spot still more accurately. The errors were found to depend more on the training of the men who had to find the range than on anything else. The ranges were found to be exceedingly good with well-trained men, and we usually found that a man was well trained after he had been at work about a fortnight. Major White, who is an instructor in range-finding, says that months of practice are required, but that is not my experience. I also have been an instructor, have had a good deal of practice with this particular range-finder, and I have not found it so at all with a good system of training. Major Featherstonhaugh also mentioned that astronomical observations can be very accurately taken; no doubt they can, but then think of the time they take! If you go into minutiæ you can take ranges with extreme accuracy; you take your theodolite, and you measure bases and so on, but what I look for is speed.

Major FEATHERSTONHAUGH: I said that the mean error was no guide to what the extreme error might be.

Colonel RICHARDSON: I do not know that; that is a mathematical question I will not go into. I think the mean of many observations gives a very fair idea. It appears that Major White's idea is that a range must be found from an exact point. To me a yard or two one side or other of a fixed point makes very little difference, because I can add two or three yards to the range found without difficulty. Although I have taken many thousands, perhaps hundreds of thousands, of ranges, I have never found these difficulties about the base, though no doubt difficulties may be found if sought for. There is certainly no difficulty in getting the objects practically in the true plane. The eye alone tells you that. Look at the number of ranges which have been found, and are constantly found, with this instrument with a close approach to accuracy. I do not think there can be any great inaccuracy in it from this cause. There is occasionally, but very rarely, a difficulty in finding a distant point, and then the simplest way is to send out a man, which is done extremely quickly, and you get very fairly accurate range results. I have not found that two observers always fall into error. My experience is you can train men to work perfectly well together. Major White claimed to know the working of the Weldon instrument very well, but talked of the instrument measuring the angles at the base with a base of only 1 in 50. I tried to explain that the base for observing purposes in the Weldon is the far-off point, and not the base of 1 in 50. I particularly tried to point that out, and I am sorry that I did not make myself well understood.

The CHAIRMAN: We have another paper before us, and as the time is passing rapidly, I will only make one or two observations on Colonel Richardson's paper. It so happens that when I was in Calcutta I had the opportunity of trying both range-finders, the Watkin and the Weldon. I greatly admired the Watkin range-finder, and thought it a marvellously ingenious instrument, but much too delicate for rough usage. I certainly did think that the Watkin range-finder in the hands of the British soldier would be likely to be soon damaged irretrievably; but Major White says he has great experience of it, and found it answer very well. As regards the Weldon range-finder, it so happened that the chief assistant of my mathematical instrument office in Calcutta, Mr. Bolton, constructed what he called the Bolton range-finder, which was the same in principle as the Weldon and made with similar glass prisms, but with angles which, I think, were a little different.

He also constructed an ingenious stand for holding the instrument, and claimed that with the assistance of this stand he could get very much more accurate results than could be got by holding the instrument by hand. In certain instances his distances were checked by triangles measured with 8 and 10-inch theodolites, with great accuracy by practised surveyors, and they came out remarkably well. But I pointed out to him at the time that he could not expect to always have a great plain, as the *maidan* of Calcutta, to carry on observations of this kind; if he went up any of the adjoining streets, and wanted to know the distance of an object 400 or 500 yards off, he could not measure it; he could not have a sufficient base for the measurement, the breadth of the streets being inadequate. It struck me, therefore, there was an objection to the Weldon range-finder, in that it necessitated a compulsory length of base, one-fortieth or one-fiftieth of the distance of the object measured. I think we must all be very much obliged to Colonel Richardson for bringing the matter forward, for it is desirable that our Officers should know as much as possible of all the range-finding instruments which have been invented. I feel sure then that you will all join with me in giving a cordial vote of thanks to Colonel Richardson for his interesting paper. I have now to introduce Mr. A. Mallock, who has another instrument to describe to you, one of a very different kind, for it enables ranges to be found by measurement from short bases instead of long ones.

NOTE ON A SHORT BASE RANGE-FINDER.

By A. Mallock, Esq.

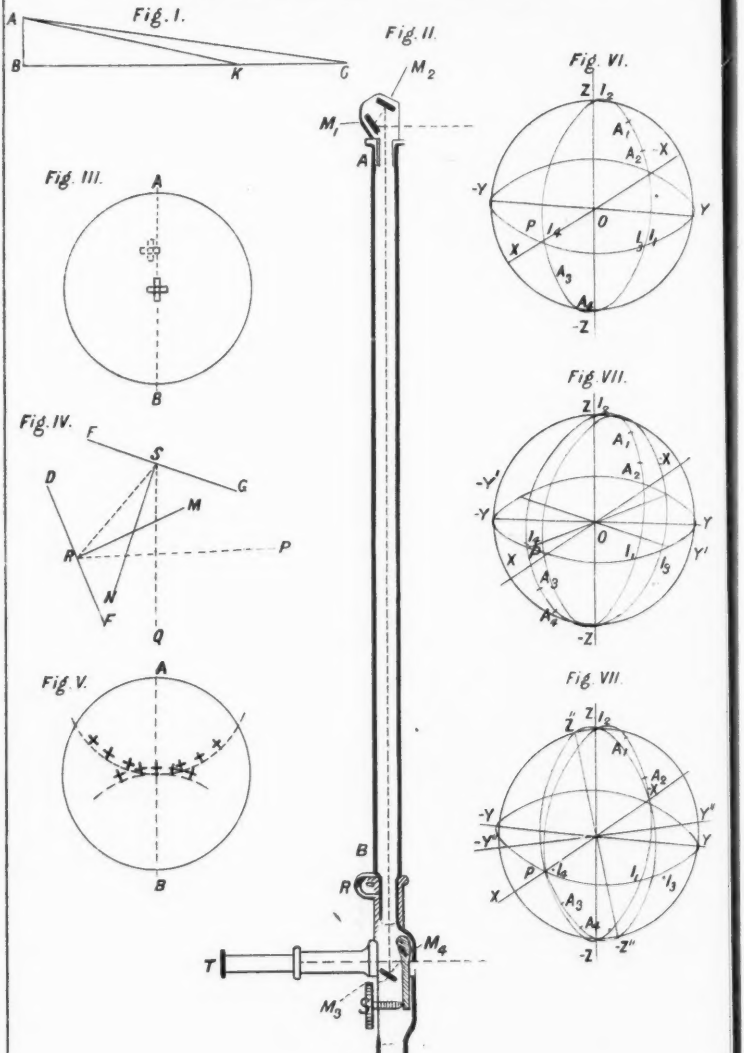
By the kindness of the Council of the Royal United Service Institution I am allowed to bring to your notice a range-finder having a base not more than 5 feet long, which is intended to give ranges up to 2,500 or 3,000 yards, with an error of, perhaps, a little more than 100 yards at the latter distance.

For the purpose of more easily comparing the actual performance of the instrument with its theoretical capabilities, I will, before describing its construction, consider one or two questions connected with distance measuring in general. Although these questions are doubtless familiar to all present, they will serve to bring into view the limits of accuracy attainable with short base instruments. The first principles involved, which are common to all distance measurements, will thus be separated from the mechanical and optical details of the particular instrument before you.

Measurements of distance depend in general on the knowledge of the angles of a triangle and the length of one of its sides, but when, as in range-finding, the angle opposite the base is very acute and the triangle is either nearly isosceles or right angled, the values of the acute angle and short side are all that are required for a very approximate measure of the length of the remaining side.

Dealing only with such acute angled triangles, I will inquire what error is produced in the result by a given error in the measurement of the acute angle. In the triangle ABC, of which C is the acute angle, let p be the ratio of AC to AB, and $KAC = \partial C$ the error in the measurement of C, then KC, the error in the measurement of AC due to the error ∂C, is $\frac{AC}{AB}\partial C \times \frac{AC}{AB}$ or $p^2\partial C$, taking the length of AB as unity;

TO ILLUSTRATE MR. A. MALLOCK'S PAPER ON A SHORT BASE RANGE FINDER.



Harrison & Sons, Lith., St. Martins Lane, W.C.

and if a be the length of the base in yards, the error in yards is $ap^2\delta C$. The percentage error is, of course, $p\delta C$.

I will now apply this expression to determine the greatest value which may be given to p when a given accuracy is required in the result; or in other words, when a certain range has to be determined to a given degree of accuracy, how short a base may be employed for the purpose.

The quantity δC, the probable error in the observed angle, depends partly on the observer, and still more on the nature of the object observed, but assuming that the observer is good and the object well-defined I shall, I think, be rather over-estimating the quality of observations made with the naked eye in putting the probable error as one minute of arc. In certain cases, as with a sextant when the images of very well-defined objects, both distant (the sun and a clear horizon for instance), are used, rather better results may be got, but in general a minute of arc may, as far as my experience goes, be taken as the limit of accuracy attainable without the use of telescopes.

Let e be the permissible error per cent. in a given required range,

$$\text{then} \qquad e = p\delta C,$$

$$\text{and} \qquad p = \frac{e}{\delta C};$$

$$\text{or since} \qquad \delta C = 1' \text{ and } 1' = \frac{1}{3500} \text{ nearly},$$

$$p = 3500 \times e.$$

Suppose e equal to 1 per cent., then $p = 35$, and if the range which is required is 1,000 yards, the length of the base necessary to measure this distance correctly to 1 per cent. is 1,000 ÷ 35 or 30 yards nearly.

As the probable lineal error in the range increases as the square of the ratio of the range to the base, a 30-yard base would give a probable error of 40 yards at 2,000, and 90 yards at 3,000 yards range.

It seems plain then that, without the use of telescopes, there is no chance of attaining useful accuracy with bases short enough to form part of a portable instrument.

If, however, a telescopic power of 10 is used and we are content with an accuracy of 2 per cent. at 1,000 yards, the base required is reduced to a length of $1\frac{1}{2}$ yards.

I think it may be said then that, however perfect the arrangement of an instrument using this magnifying power and length of base, each single observation cannot be expected to give results closer than about 20 yards at 1,000, 80 at 2,000, and 180 at 3,000 yard ranges.

This magnifying power and length of base are nearly those which I have employed, believing that 10 is about the power which can be most effectively used in a telescope of the size required, and which is to be held in the hand without fixed support; and that 5 feet is about as long a base as can be handled easily under the same circumstances.

Having thus roughly examined what might be expected of a perfect range-finder of the dimensions I have named, I will describe the principle and details of my own.

Fig. 2 is a section of the instrument.

The base AB is made of a piece of hollow bamboo, and at A are a pair of mirrors M inclined at an angle of 45° to one another. The lower end of the base B is held in a stock H in which there are another pair of mirrors similar to those at A, except that the angle between them is not fixed at 45°, but can be slightly altered by the micrometer screw S. T is a telescope which looks partly into the mirror at M_4, and partly on one side of it in the same way as does the telescope of a sextant.

Suppose now that the telescope is directed to a distant object; that object is seen in the ordinary way by means of the rays which pass beside the mirror M_4; but rays from the object also fall on the mirrors at A, and being reflected from the various mirrors in the order, M_1, M_2, M_3, M_4 (as shown by the red lines) at last enter the telescope and form an image of the object in the same field as that occupied by the direct image (Fig. 3). The micrometer screw S is turned until by altering the angle between the mirrors M_3, M_4, the two images of the object are made to coincide, and the distance of the object is then read off on a divided scale, in front of the milled head of the micrometer screw.

It may be asked why there should be two mirrors at each end of the base instead of one, and as this point is very important, the possibility of using a short base depending on it, I will examine the course of the reflected rays in greater detail.

In Fig. 4 let DE, FG, be two mirrors; let a ray PR fall on DE, and being reflected from DE and FG follow the course PRSQ, let RM be the normal to DE and SN be the normal to FG.

Let α = angle between DE and FG.

ι = PRM.

θ = PIQ the angle which the ray incident on DE makes with that reflected from FG.

This angle PIQ = RIS = 180° − (IRS + ISR),

and IRS = 2ι.

and ISR = $2(\alpha - \iota)$.

$\therefore$ $\theta = 180 - (2\iota + 2\alpha - 2\iota)$,

or $\theta = 180° - 2\alpha$.

That is to say the angle between the rays approaching and leaving the mirrors depends only on the angle between the mirrors, and not on the angle at which it falls on them.

The ray then, which falls on the mirrors at the far end of the base is always turned through a right angle, because these are placed at 45°. The lower pair of mirrors turn it through an angle which can be varied by the screw S, but which is always, as before, twice the angle between them. The relative position therefore of the two images, of an object in the field of the telescope, one formed by reflection and the other directly, depends only on the angle which the members of each pair of mirrors make with one another and the distance apart of the pairs, not on the angle at which the pairs are presented to one another. In fact, as long as the rays from one pair can enter the other, and the

angles between the mirrors composing each pair kept constant, the position of the direct and reflected images remains unchanged.

This property makes rigidity in the base unnecessary; whereas, if the reflection was effected by single mirrors, rigidity, combined with constancy of shape, would be an indispensable condition.

What has just been said refers only to movements in the plane containing the perpendiculars to the mirror. The effect of turning either of the pairs about the axis of the base or an axis parallel to that of the telescope I will mention presently.

When it is considered how very minute are the angles which have to be measured in finding long ranges with a short base, it will be seen how important it is that results should not be dependent on any supposed rigidity or constancy of shape in the base itself. For instance, a base of 5 feet at 2,000 yards subtends an angle of 1 in 1,200, and to measure this angle correctly to within 4 per cent., which was before mentioned as the accuracy possibly obtainable with such a base, the error in the angle must not be greater than $\frac{4}{25}$ of 1 in 1,200 or $\frac{1}{300}$ which is about 7″ of arc, but the mere accidental motions caused by the hands when holding the base make the latter bend by many times this amount. If then, instead of using a double reflection at each end of the base, a single mirror had been substituted, it would have been found impossible to make any trustworthy observations at all, for the reflected image in this case would be continually shifting through an angle twice that of the deflection of the base.

To illustrate this I have placed two pairs of mirrors on an upright stem, in the same relative position which they occupy in the range-finder, and as it is impossible to show simultaneously to an audience the images of an object reflected by the mirrors, in the field of a telescope, I will reverse the action of the instrument. In place of the eye I put an electric lamp and substitute a collimator for the telescope. The lamp now sends a pencil of parallel rays in part direct to the screen at A, and in part, after being reflected from the mirrors, to the screen at B.

The distance AB is now equal to the base, that is to say, to the distance between the pairs of mirrors. The two beams of light therefore are parallel, and proceed as if directed to an object infinitely distant. The angles therefore between the mirrors composing each pair are equal.

When I alter the angle between the mirrors of one pair, the spot of light at B moves towards A, and the beams instead of intersecting at infinity, intersect at the distance indicated on the scale I have placed on the screen opposite the spot of light. I will now cause the stem, which has been purposely made slender, to vibrate in the plane passing through it and the beam. You see that the spot of light does not alter its position on the scale. I now substitute a single mirror for each of the pair of mirrors, and adjust these single mirrors to reflect the light to B as before, but when the stem is caused to vibrate, the reflected beam is by no means stationary, although the motion of the stem is so small that it can hardly be seen, even by those who are quite close.

In any instrument which is likely to meet with rough usage, it is of course very important that such adjustments as may be necessary should either not require great nicety or not have to be often applied, and that when correction is necessary, it should be easily effected.

There are three adjustments in the range-finder before you, namely :—

(1) The perpendicular to the mirrors forming each pair should lie in a plane passing through the axis of the base.
(2) The axis of collimation of the telescope should also lie in this plane.

These two conditions need only be fulfilled approximately.

(3) When the angle between each pair of mirrors is identical, the index of the micrometer screw must point to the sign of ∞ on the divided head.

This means that when the angles between the pairs of mirrors are equal, the two images of an infinitely distant object seen in the field of the telescope coincide, and therefore the distance indicated must be infinity. This adjustment may be made in several ways, either directly, by making the two images of a star to coincide and then setting the index to ∞, or indirectly by observing an object at some known distance and then setting the index to that distance; but the best way, which is independent of known distances and which can be applied in almost any situation, is given by the following rule :—

Remove the bamboo base and place the upper mirrors in the stock, take an observation of any well-defined object, and set the index to ∞. Then replace the base and again observe the same object. From the distance then indicated subtract one-tenth part and set the index to the remainder. The adjustment is then complete.

The *rationale* of this rule is, that since when the base is used, the pairs of mirrors are 5 feet or 60 inches apart, and when the mirrors are placed in the stock this distance is only 6 inches, the angles measured by the instrument in the latter condition are one-tenth those measured in the former. Setting the index to ∞ after the first observation is equivalent to ignoring the six inches between the mirrors altogether, and, therefore, when the sixty-inch base is again introduced, the angle measured is nine-tenths and the distance recorded is ten-ninths of what it should be. Thus subtracting one-tenth of this ten-ninths the remainder is the actual distance.

In the use of the instrument I find by experience that it leads to more accurate results, if instead of attempting to make the reflected and direct image actually coincide, the mirrors are so adjusted that the reflected image falls a little on one side of the direct one, the eye then has to judge when the two images are similarly placed with regard to a line at right angles to the base, or if the base be held vertically, when they are on the same level. To allow of the mirrors being adjusted for this purpose, the bamboo base and upper pair of

mirrors can be rotated round the axis of the former by the tangent screw R, Fig. 2.

The best distance apart at which to place the images can only be found by practice, and varies much for different classes of objects, the least definite objects as a rule requiring the largest distances.

As the adjustment just referred to is effected by rotating one pair of mirrors with reference to the others, I may here mention what the actual path of the image in the field of the telescope is when the mirrors are thus relatively rotated about the axis of the base and also when the rotation is about the axis of the telescope (a rotation of this kind is produced by a sideways bending of the base), these being the two rotations not considered when I referred to the use of double reflection. The geometry of the question is given in a note at the end of the paper, but the result is as follows. A small rotation about the base causes the reflected image to describe a circle about a point situated in the plane containing the axis of the base and the axis of the telescope, the motion of the image is in the plane of the field and the distance of the centre of motion from the image is equal to the distance of the image from the eye, and on that side of the axis of the telescope away from the base. Rotation of the mirrors about the axis of the telescope causes the image to move in a circle of equal radius, in the same plane, but the centre of motion in this case is on the base side of the axis of the telescope in Fig. 5. The angles through which the image is rotated being in both cases equal to the rotation of the mirrors.

When adjustment 1 is approximately correct, either of these rotations cause the image to move at right angles to the direction of the base, and, therefore, do not affect the motion given to the image by the micrometer screw which is parallel to that direction.

Any possible rotation of the mirrors can be compounded of rotations about three axes at right angles to one another, and it has been shown that about one axis, viz., that at right angles to the base and telescope rotation produces no effect, and that about the other two, the effect has no component parallel to the base.

On the whole, therefore, it appears that no moderate bending or twisting in the base can in any way affect the readings of the micrometer.

Of course the value of a range-finder must be estimated by the results it gives, and not by any theoretical immunity from error, so what I have just said is merely to point out the ways in which errors will not occur.

To show the kind of accuracy which is attained, I subjoin a table of a set of observations made by me on 4th of March of this year.

Observations made on March 4th, 1886.

PLACE OF OBSERVATION: Hill S.E. of Stafford Bridge, near Exeter.
WEATHER: Hazy; Sunshine with intervals of Cloud.

Observations begun at 12.10 P.M. Instrument adjusted at 12.15 P.M.

Description of object.	Observed range.	True distance.	Greatest deviation from mean.	Theoretical probable error for single observation.	Error of distance.	Time at which each set of observations was completed.
Parsonage House at Brampford Speke	2250 2300 2370 2250 2380 2300 2300 2400 2250 2260		94	92		
	2306	2300			6	H. M. 12 20
Pynes House	935 930 920 930 950 940 930 935 930 950		15	14		
	935	925			10	H. M. 12 22
Cowley Place	1780 1810 1720 1780 1790 1800 1730 1720 1730 1780		45	48		
	1764	1760			4	H. M. 12 24

Description of object.	Observed range.	True distance.	Greatest deviation from mean.	Theoretical probable error for single observation.	Error of distance.	Time at which each set of observations was completed.
oke Paper Mills..	1680 1700 1780 1730 1800 1740 1680 1730 1730 1780		65	48		
	1735	1780			45	H. M. 12 26
oke Church.....	2880 2750 2600 2950 2850 3000 2750 2850 2750 2850		227	140		
	2827	2850			23	H. M. 12 29

Column I gives the nature of the object. Column II the range as found. Column III the true distance taken from the Ordnance map. Column IV the greatest deviation from the mean. Column V the theoretical probable error at the range with 5 feet base. Column VI the error; and Column VII the time at which each set of observations was finished.

It will be seen that the ranges obtained are not in all cases as near the true ranges as the consideration of what was theoretically possible led me to expect as the limit, but they approach it.

In using the range-finder I find it most convenient to hold the base vertical or nearly so, as then the weight of the instrument has no tendency to twist the hands, but in addition to this there are other advantages in the position. In the first place the observer may be almost in complete shelter; and, secondly, since most of the leading lines in a landscape are horizontal or nearly so, such as hedge-rows, outlines of hills, &c., these form as good objects for a vertical base to measure to as vertical lines do for a horizontal base, isolated objects being equally available for both.

The chief difficulties I have met with while constructing the range-finder have been getting the mirrors flat enough and getting sufficient light for the reflected image. In fact the want of light in the reflected image is its worst defect, for though in moderately good daylight this is not felt, yet in misty or dark weather it adds much to the difficulty of making observations.

If it were admissible to use a support, larger mirrors and a higher telescopic power might be used, in this case too the base might be doubled in length or more, and no inconvenience as to transport would be occasioned by this, as the base could be carried in short lengths and put together like a fishing-rod, and with such an instrument a high degree of accuracy could be obtained even at long ranges.

Even as it stands, however, though doubtless capable of much improvement in many of its details, I think the table shows that this range-finder is capable of giving results with a useful amount of accuracy and with considerable rapidity.

Note.

I have found the following method a simple one for tracing the position of the successive images of an object reflected by several mirrors. For the purposes in view the planes of the mirrors may be supposed to intersect in a point: take this point as the origin, and about it describe a sphere passing through the object. It is easy to see that the images of this object after any number of reflections will always be on the surface of the sphere.

In the case of the four mirrors used in the range-finder, O being the centre of the sphere, and P the object, let OX, OY, OZ (Fig. 6) be three axes at right angles to one another, also let A_1 and A_2 be the points at which the first and second mirrors, M_1, M_2, respectively cut the quadrant Z, $-$X of the sphere, and Y the line in which their planes intersect.

The angle $A_1OA_2 = \frac{\pi}{4}$ by hypothesis, therefore the image of P in M_1 will be at some point I_1 in the quadrant $-$ X, $-$ Z, and the image of I_1 in M_2 will be at Z from the property of double reflection.

Let A_3, A_4 be the points where the third and fourth mirrors M_3, M_4 cut the quadrant X, $-$ Z, and if M_3, M_4 intersect in Y, and $A_3OA_4 = \frac{\pi}{4}$, the image of I_2 in M_3 will be at some point I_3, and the image of I_3 in M_4 will be at P, coincident with the object.

To examine the effect on the position of the image I_4, of rotating one pair of mirrors about Z (the axis of the base): Let the axis of intersection of M_3 M_4, be OY′ (Fig. 7), making an angle θ with OY in the plane XY. Then I_3 and I_4 will lie in the great circle through Z and X′, making an angle θ with OX, and since the image I_2 makes an angle θ with the plane Z, X′, $-$ Z, I_3 and I_4 will be also inclined to Z, X′, $-$ Z, at this angle. I_4 is therefore displaced through θ in the plane XY, and rotated through θ about the axis X′O; or in other

words for small values of θ the image I_4 moves as if it were carried by a rigid arm about a centre in the plane ZX whose co-ordinates are X = PO, Z = − PO.

Next take the case of one pair of mirrors being rotated about OX (the axis of the telescope).

Let Y″O (Fig. 8) be the intersection of the second pair, and let Y″OY = ϕ. I_2 is distant ϕ from the great circle Z″, − X, − Z, P, which is in the plane perpendicular to the planes of the altered mirrors, therefore I_3 and I_4 will also be distant ϕ from this plane; and since at I_2 the great circle through Z″, X, is parallel to that through Z, X, the images of I_3'' I_4'' will make the same angle with the plane Z″, X, − Z″ as P or I_1 or I_2 do with Z, X, − Z, P.

Hence since Z″, X, − Z″, P, makes an angle ϕ with the plane Z, X, Z, P, the image I_4 is rotated through ϕ, and we have already seen that it is distant ϕ from the plane Z″, X, − Z″, P.

Hence rotation about OX for small values of ϕ give a displacement and rotation of the image, each equal in amount to ϕ, and attending to the signs of these quantities, we see that the co-ordinates of its centre of motion are X = OP, Z = OP.

If right-handed rotation is taken as positive, it will be further seen that calling angular motion about Z, θ, about X, ϕ, and about Y, ψ,

$$\left.\begin{matrix}\text{a rotation } \theta=\alpha \\ \phi=\alpha \\ \psi=\alpha \text{ (for any value of } \alpha)\end{matrix}\right\} \left\{\begin{matrix}\text{of the mirrors for} \\ \text{small values of } \alpha\end{matrix}\right\} \left\{\begin{matrix}\theta=-\alpha. & \phi=-\alpha. & \psi=0. \\ \theta=\alpha. & \phi=-\alpha. & \psi=\alpha^2.\end{matrix}\right.$$

$$\theta=0. \qquad \phi=0. \qquad \psi=0.$$

It should be observed that whilst in the case of rotation about Z, the image I_4 remains in the plane XY, this is not the case for the rotation about X, the image in the latter case being distant from that plane by a quantity α^2. For this reason sideways bending of the base is objectionable, although the error introduced is of the second order.

The CHAIRMAN: We shall be happy to hear anything that Major White may have to say on this subject.

Major WHITE: It seems to me that anything we might have had to remark in the way of criticism on this paper has been anticipated by Mr. Mallock himself, so that I have really nothing to say. In the last discussion I was talking about something that I had tried, and was speaking from personal experience. This is quite a new instrument, and so far I think rests almost entirely on theory. It is, however, a very interesting proposal, and I should like to hear something more about it.

Captain C. B. MAYNE, R.E.: Sir, if the range-finder that has just been described really has all the advantages which have been claimed for it, I think Mr. Mallock may be congratulated, for it is an instrument which will be found very valuable for infantry purposes in the field. I do not see why one or two of these range-finders should not be carried by each company. There is no greater difficulty in the use of it than in holding up a rifle. It certainly has a great advantage, as I pointed out just now, that other range-finders have not got, namely, that you have one base with which you can take several ranges without having to alter the direction of your base. I think that is the great fault of all the other range-finders. With this range-finder you have no pacing up and down the line under fire; you can get behind a wall or any other cover that exists and take your range. Of course this is the first time that I have seen it, and speak without having tried it. Mr. Mallock has

given an account of some very remarkable trials, and I think his figures show what Major Featherstonhaugh pointed out, namely, the great difference there is between a single error and the mean of errors. The mean error of the first range was 6 yards over the true, but the greatest error was 94 yards, and I think that all range-finders should be tested by the greatest error that they give. I think that Mr. Mallock should design his instrument separately for artillery and infantry purposes, and in the latter case ranges suited only to infantry fire, of which the limit is about 1,500 yards. That is about the maximum. If Mr. Mallock would make his instrument shorter, so as to suit that range, and still find the range within 50 yards,[1] I think we should have a perfect infantry range-finder. The other day I wrote about range-finders, and a friendly critic said I had laid down too hard conditions. I find that instead of my conditions being too hard, Mr. Mallock has satisfied them all, and gone beyond what I expected in their use. I can see another use for an instrument like this, for rough military eye sketches, as certainly it gives ranges with sufficient accuracy for that purpose in the field. Supposing that you have to reconnoitre your enemy's position without a compass, you can take your distances as you go along without any trouble, and get results quite within the limit of errors allowable. If that instrument is subsequently found to answer I think it is a pity it has not been kept confidential, and kept for our own Army.

A MEMBER: What is about the cost of the instrument?

Mr. MALLOCK: That is the only one that at present exists, and I am afraid to say what it costs.

A MEMBER: What is the weight?

Mr. MALLOCK: This instrument is rather heavy; it weighs 5 lbs.

Major FEATHERSTONHAUGH: A similar idea occurred to me some time ago, and I tried it, though not so well as Mr. Mallock has tried it. I then found the difficulty was that I could not get the object into the upper field of view, because the field of view is very small.

Mr. MALLOCK: You cannot help getting it with this instrument, the two things are bound to be together.

Major FEATHERSTONHAUGH: With regard to the errors of range the greatest deviation from the mean of 2,300 yards is 94; that is not very small; but when you look at the last range, 2,800 yards, only 500 yards greater, you find the greatest deviation from the mean is 227 yards.

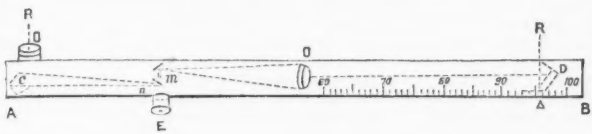
Mr. MALLOCK: It is perfectly true; as you get on the percentage of error increases, but that is rather an exceptionally bad observation, and no doubt a man who was observing, and found that he had one exceptionally bad observation, would throw it out.

The CHAIRMAN: I will now introduce to you Mr. Adie, the well-known instrument maker in Pall Mall. Many years ago he constructed a telemeter, which in principle is very similar to this one of Mr. Mallock's, though different in details. You will probably like to hear what he has to say about it.

Mr. ADIE: I need scarcely say anything about this instrument, the first telemeter; it is pretty well known, I think. It is very portable and has one advantage which I think Mr. Mallock will recognize at once. In observing with this instrument you have simultaneous observations with two telescopes, and the image is divided into two, so that whatever your object for observation, whether the side of a house, a chimney, or a man, you line any straight or even curved line of said object with itself, greatly preferable for accuracy to covering the object by itself. There are two telescopes: one works into the upper part of the eye-piece and one works into the

[1] Or rather, as pointed out in the footnote on p. 513, 100 yards, and to within 50 yards at 1,000 yards. The artillery could easily use a much longer range instrument, as it could be rested across the two wheels of a gun or held on a stand, but it is doubtful whether the instrument will be of any use at all to artillery, which will have to open the fight now-a-days at ranges over 3,000 yards and even up to 5,000 yards at times, and to know its ranges exactly, if any result is to be obtained from its fire. One point that has not been referred to in Mr. Mallock's instrument, and which should be noticed, is the extreme rapidity of taking ranges with it—ten estimates were made in from two to three minutes only! A very great advantage.

lower part, and that enables you to read to two seconds instead of ten seconds. The limit of the instrument is of course the power of the telescopes. It is a very compact instrument, and I have the longest possible telescope for the length of the instrument. With this small size I can read to five seconds, or even less than that, and with the 3-foot of course I can read to two seconds. This instrument has been applied a good deal in civil surveys in measuring inaccessible distances, &c. A short time ago Major Featherstonhaugh brought a suggestion to me which has dwelt very much on my mind ever since, and which I think ought to be brought into use. He suggested that instead of the scale I should adopt a double mirror, shifting the position of the second object-glass to the end of its tube, and by that means get rid of the great difficulty of flexure by sun's rays or otherwise, and also reducing the work and so the cost, while the length of the base is easily increased, and the reading upon a common scale more simple. Reference to the diagram below will



better explain how this is arranged. AB is the base, square by preference, which for illustration may be called 10 inches in length, OO are the object-glasses of the two telescopes directed by the intervention of the mirrors D, *c*, *m*, *n*, when observing to the same object, the rays coming in the one are in the direction R, D, O, *m*, E into the upper half of the eye-piece E, and in the other case in the direction R, O, *c*, *n*, E into the lower half of E, then if the scale is in the proportion of one-tenth of an inch to 100 yards, a coincidence of the parts of the image when the mirror D stands at 100 on the scale shows the distance of the object to be 100 yards, at 90 on the scale 90, and so on. Unfortunately I have not yet carried out the suggestion, but I mean to do it. I think it would be a very neat thing, and I am much obliged to Colonel Featherstonhaugh for suggesting it. I may mention that forty years ago a gentleman, now a patent agent, and in a very good position in that profession, came to me to make a range-finder for him, which he thought he would patent. It was that very thing made in this way: he had one telescope at the end at right angles to the base, and he had a single slide mirror sliding along the base, but the exceeding difficulty of making or keeping the base absolutely straight rendered accuracy impossible, otherwise it would have been a very nice instrument. I think a telescope at right angles is rather an objection, being less convenient for observation. The double mirror instead of being made a double mirror might be made a solid prism, keeping the two faces of entrance and exit at right angles to the rays.

Captain MAYNE: What is the range?

Mr. ADIE: This gives a scale up to a thousand on the instrument, and a printed scale going up to 2,000 yards. The larger instruments in like proportion.

Major FEATHERSTONHAUGH: I did use one of Mr. Adie's telemeters in India up to 1,000 yards. I used it as a position-finder, and not as a range-finder.

Mr. ADIE: I first used double reflecting prisms, but found them very difficult to fix. I afterwards used speculum metal reflectors, and found them a very great improvement; in fact, that was the real objection practically to the instrument, that it required to be tenderly dealt with. I have always maintained the simplicity of this instrument, because I can take an observation in five seconds. I can take a man on horseback at 3,000 yards, and come up to about 100 yards of the true distance with the 3-foot instrument.

The CHAIRMAN: Gentlemen, I have had a little experience with Mr. Adie's instruments myself, and in theory I admire them very greatly indeed, but I am bound to say that when I lent one to some Officers in India to use for range-finding, they could make nothing of it. I believe this was mainly due to the fact that the Officers themselves had not been trained in its use. If an instru-

ment of this kind were to be sent to the School of Range-finding under Major White, and put in his hands, I dare say in a very short time he would teach his Officers how to use it properly; but unfortunately I had to put the instrument in the hands of men who had first to find out how to use it. Another instrument I placed in the hands of Major Featherstonhaugh, and he soon mastered it, and got very good results indeed from it. Mr. Adie made a telemeter for me, which was a little different in construction from the one now exhibited. Instead of having one of the telescopes in a movable arm on one side, both the telescopes were fixed, and you saw two images of the distant object in the centre prism. There was no attempt to make the images lap over each other, as in a sextant; they were purposely looked at as two separate objects, and the distance between them was measured with a micrometer, as in Mr. Mallock's instrument. This is the method that I should personally prefer, but those who are accustomed to the use of sextants and reflecting instruments will probably prefer the original method. I experimentalized with the instrument, and came to the conclusion that although the design was very beautiful and ingenious the metal frame was too thin and flexible, and thus the adjustments were not sufficiently permanent. They were, moreover, very difficult to execute. The instrument was covered over with a leather case, and this case had to be wholly removed in order that the adjustments might be effected. I had them made by setting the instrument on the sun, for I was in Calcutta at the time; the atmosphere was very hazy and thick, and there was no seeing distant opaque objects. The sun of India is of course trying, and it told on the thin metal frame of the instrument; thus after the adjustment had been made, and the instrument was put back into its leather case, and allowed to cool down, it was found to be much out of adjustment. I think, however, that an instrument of the same kind, but with a more solid frame, would be found to answer very satisfactorily, and would be better suited for rough work in the field, and to be entrusted to soldiers. We have had a very interesting afternoon, and I am sure you will all join with me in returning thanks to Mr Mallock for the valuable paper he has read to us. More than one of the Officers now present who are familiar with range-finders has told us that he either never heard of or has never used a range-finder constructed on the principle of Mr. Mallock's and Mr. Adie's instruments. I think it will be a very good thing if Officers who are in a position to learn and teach others how to use these instruments would avail themselves of their opportunities to give them a chance of being thoroughly tried and tested.

Friday, March 26, 1886.

REAR-ADMIRAL W. ARTHUR, C.B., Member of Council, in the Chair.

DESCRIPTION OF THE "REMINGTON-LEE" MAGAZINE RIFLE.

By Major ARMSTRONG, late A.P.D.

INTO the general question of repeating or magazine small-arms, which is still becoming daily of greater extent and importance, I do not propose to enter; most of my hearers know quite as much of it as I do. But I may say that, apart from the considerations which are common to all military rifles, such as breech-action, calibre, trajectory, &c., the desiderata in general as regards the magazine system, whatever it is, may be considered as narrowed down to the getting rid of the four principal objections still to be found more or less in all repeating arms.

These objections are:—

1. The awkward distribution of the weight of the magazine and its charge, which is generally disposed in the way most irksome to the soldier.
2. The alteration of the centre of gravity, and therefore of the "balance" of the rifle, which follows each shot.
3. The danger of explosion in the magazine, the cartridges necessarily resting (in tube magazines) *à la file*, a danger which has been found very real and serious.
4. The practical impossibility of knowing if the magazine is really kept in reserve while the arm is being used as a single loader.

They are inseparable from all of the large family of repeating arms which carry their magazine in a tube either in the butt or under the barrel, of which classes the Spencer and the Winchester are respectively the prototypes. The third objection has been got rid of in some cases, of which, I think, the Evans was the earliest, by converting the whole butt into a magazine with spiral feeding action, at the cost, however, of enhancing greatly the second and enormously the first objection. The importance of the fourth can scarcely be overrated, from the strictly military point of view, it appears to me. The best of soldiers are naturally inclined in the excitement of action to fire away their ammunition fast, and notwithstanding the strictest orders

to keep the magazine in reserve and use the arm as a single-loader until the occasion arose for a rapid and concentrated fire, the majority in any body of men would be pretty sure to draw on their magazines as long as there was a shot in the locker. An Officer then could not possibly know whether his men really had magazine arms in their hands or not, unless he examined each arm separately, emptying from it and replacing all the cartridges.

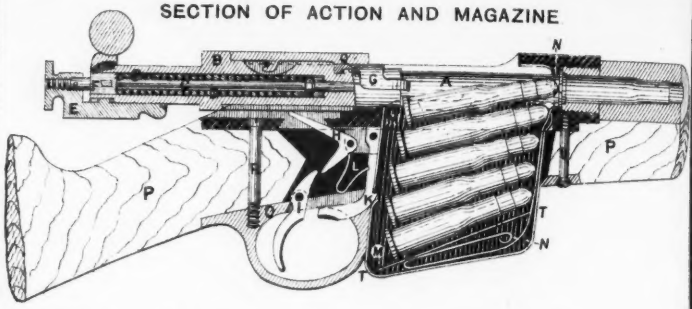
Several attempts, therefore, have been made to adopt a repeating or "quick-firing" attachment to the ordinary breech-loader, so as to convert it for the moment into a repeater, but they all leave much to be desired as regards strength, handiness, sightliness, quickness of action, and above all rapidity of adjustment and replacement; with none of them, in fact, can the result be considered really a magazine rifle. It is in this direction that inquiry and experiment are naturally tending more and more, and I think there can be little doubt the arm of the future will be the best single-loader obtainable, *plus* a good attachable magazine system.

I think you will find that practically that ideal has been attained, as regards the latter half at any rate, in the arm I have now the honour to submit to you. It is the "Remington-Lee" rifle, invented and patented by Mr. Lee, and made by Messrs. E. Remington and Sons, of New York. It is at this moment a simple breech-loading rifle, with bolt action, differing little from other bolt systems except that it is simpler and stronger than most. This particular model is of 0·45 calibre, rifled with five grooves, taking a complete turn in 20 inches; weight about 9 lbs.; and takes the United States service cartridge of 70 grains of powder with a bullet of 405 grains, giving an initial velocity of about 1,350 feet per second. And the action is particularly quick and easy, as you see.

The principal feature of this arm was brought to the notice of the Institution, along with other repeaters, in a paper on the subject generally about three years ago. The arm itself, however, was not presented to you, and since then there have been numerous improvements effected in both the breech and magazine systems; the rifle, too, has in its present form been taken up experimentally by almost every European Government, as yet without any decision arrived at.

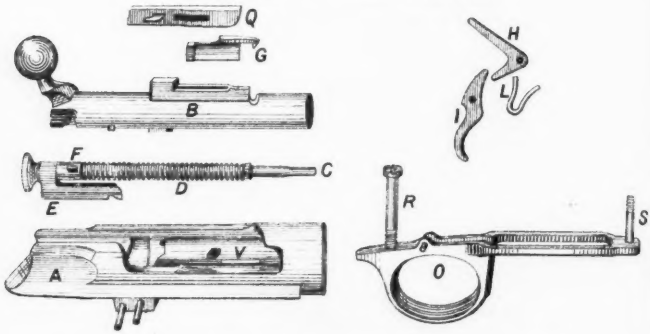
The details given can of course be varied to any extent desired in the manufacture; the important feature is the independent magazine system. The arm can be used indefinitely in its present form as a single-loader, until the necessity arises for the quickest and most concentrated fire obtainable, when it is converted in a moment, at the word of command, into an almost inexhaustible repeater of the most rapid action. Any desired quantity of reserve ammunition can be served out in the magazines which I produce, each containing five cartridges in no greater space than if they were in the ordinary paper packages. They are made of sheet-steel in one piece, with a simple spring to propel and a "carrier" to guide the cartridges, three pieces in all. They are specially contrived to combine the maximum of strength and efficiency with the minimum of cost, though if retained they can be recharged and used hundreds of times of course. The

SECTION OF ACTION AND MAGAZINE

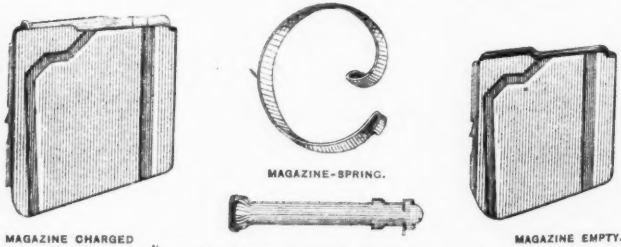


A. CHAMBER.
B. BOLT.
C. FIRING-PIN.
D. MAINSPRING.
E. DOG OF FIRING-PIN.
F. KEY OF DO.
G. EXTRACTOR.
H. SCEAR.
I. TRIGGER.
K. MAGAZINE CATCH.
L. SCEAR-SPRING (DOUBLE ACTION).
M. MAGAZINE.
N. MAGAZINE-SPRING.
O. TRIGGER-GUARD.
P STOCK.
R. & S. TRIGGER-GUARD SCREWS.
T. CARRIER--FALSE BOTTOM OF MAGAZINE

DETAILS OF BOLT SYSTEM.



A. CHAMBER.
B. BOLT.
C. FIRING-PIN.
D. MAINSPRING.
E DOG OF FIRING-PIN.
F. KEY OF DO.
G. EXTRACTOR.
H. SCEAR.
I. TRIGGER.
L. SCEAR-SPRING
O. TRIGGER-GUARD.
Q. PLATE COVERING EXTRACTOR.
R. & S. TRIGGER-GUARD SCREWS.



MAGAZINE CHARGED

MAGAZINE-SPRING.

MAGAZINE EMPTY.

"CARRIER" FORMING FALSE BOTTOM TO MAGAZINE.

Harrison & Sons, Ltd., St Martins Lane W.C.

cartridges are stowed away in them in a moment, and yet are so firmly held that it is scarcely possible to displace them unintentionally even with the roughest treatment, while as you will see the empty magazine is removed and replaced by a full one in less time than is required to insert a single cartridge in the ordinary single-loader. This quickness of adjustment is a very important feature, for though the capacity of each magazine is small, it is so easily and speedily replaced that the magazine *system* is practically inexhaustible, being really limited only by the carrying power of the soldier. The rifle has been fired from the shoulder, as a repeater, fifty times in one minute, during an official trial in America, a rate much beyond that of any other magazine arm. Such a rate indeed is probably beyond what is either desirable or necessary in practice, and is only possible to an exceptionally strong man.

To obtain the full advantage of this magazine system, it should be a detail of *administration* to pack, store, and issue on active service a certain proportion—as large as desired, it is no matter how large—of ammunition in the magazines. Taking, as I said, scarcely a greater appreciable space, and weighing little more than in strong paper packings, this reserve ammunition would then, as such, be packed in damp-proof cases like other war material; and there is no reason why the magazines should deteriorate in any way. And—this is an important point—while the soldier would of course be drilled in charging, applying, working, and replacing the magazines, it would not—as it certainly should not—be left to him to charge his magazines during action. He would, and should simply, when ordered, convert his rifle into a repeater, whose capacity as such, as I have stated, is dependent on his own carrying power *and* the administrative arrangements for keeping up the supply of ammunition in the field.

The four objections cited, therefore, do not apply to this rifle. The magazine in use offers no inconvenient projection nor unsightly feature, whilst its weight is so disposed that the centre of gravity of the rifle is never disturbed, the balance of the arm remaining therefore always the same; and the cartridges lie always side by side in the magazine, where they are really better protected from all possibility of accident than they could be anywhere else. While as to the fourth and most important objection, it is evident that the Officer can see at a glance, even from a considerable distance, whether the arm is being used as a single-loader in obedience to orders, or if any of his men has brought his magazines into play before the word of command. The charged magazines, moreover, would be carried apart from the loose ammunition until required, in separate pouches, so that to make use of them would involve a distinct and explicit drill motion.

It is not necessary for me to occupy the time of the meeting any further: I wish only to thank you for your patience, gentlemen, and will leave the rifle to your examination and criticism.

Colonel FRASER, R.E.: May I ask Major Armstrong the weight of the magazine—the iron case that contains the five cartridges?

Admiral BOYS: I have but little to say about this rifle. It seems to me to answer all the conditions which the lecturer claims for it and to be a very good

weapon of its kind. It, however, possesses the objection that was made by the first Committee that sat on breech-loading small-arms, namely that the breech action is on the bolt system, and guns loaded by a sliding bolt instead of a rising and lowering block, have generally since that Committee's report been rejected in competition in the British Service, although they are very generally approved in other countries. The block system does put many obstacles in the way of adopting detachable magazines which for rifles on the bolt system can be done with but little difficulty and expense. Of course the weight of these magazines is an important consideration when a great many of them have to be carried, and another point is that it adds considerably to the expense of a soldier's or sailor's equipment.

Colonel BAYLIS: I hope the question of expense is one that will never be taken into consideration in these matters. It is a point that we never consider as sportsmen when we go to the field shooting; and when we have the best possible weapon to kill birds, I think when a man's life depends upon it, we ought to have the best weapon, no matter what the expense.

Admiral BOYS: As an individual I quite agree, but it is a consideration with our Government as we know, and a question of even a sixpence additional expense per rifle comes up to many thousands of pounds, 50,000*l.*, or something of that sort.

Colonel BAYLIS: It may be a question of deciding a battle!

Captain CURTIS: I think in the first place this magazine adds to the grip of the gun. If you take hold of a gun or a rifle by the small of the butt you balance it, and you can press it with that magazine home to the shoulder much better, and get a steadier shot. We want efficiency at whatever cost.[1] Instead of a man having a lot of cartridges and not knowing which end he is going to get hold of first, with this magazine they are all in their place ready for use. Certainly the men should be drilled with this rifle, and should not load with the magazines till they are ordered to do so. Lord Charles Beresford told us the blue-jackets rushed to where the "Emu" was, because they thought they were wanted, but military and naval men must obey orders, and that can only be got by constant drill.[2] If a man has five cartridges in a magazine, and the enemy are nearly on to him, he is sure to use the magazine, and I don't blame him either. A man is supposed to carry sixty or seventy rounds, and with respect to the magazine I should like to know what additional weight it would represent: would it mean a difference of eight to ten rounds? I think it is a very pretty and handy weapon. The cartridge, too, seems a very good one. The cap is countersunk, so that the thing cannot go off by accident, as some cartridges will do where the cap projects.

A MEMBER: Are they waterproof?

Captain CURTIS: They ought to be. These, of course, are dummies, without powder or cap, but now-a-days there is no reason why cartridges should not be waterproof; the Service cartridge no doubt is.

The CHAIRMAN: I may state that we have had this magazine weighed, both empty and full; the weight of the empty magazine is 4¼ ounces, and of the full one 11¾ ounces.

Captain LUMLEY: Great stress appears to be placed on the weight of the cartridge holder, but the soldier need carry only a certain portion of his ammunition in those little cases; in fact, that amount necessary for use at the required moment, because the repeating rifle should only be used to repulse an attack of cavalry at the last moment, in defence of a position stormed by infantry, or just before making an attack on a position occupied by the enemy, when it would be of the greatest importance to be able to concentrate a mass of fire on the position before making the final charge. Under these circumstances, the proportion of ammunition carried in these cases should not exceed one-third of the whole amount carried by the soldier.

Captain CURTIS: Possibly these cases might be made lighter; they manufacture steel very strong now, and it is quite possible they could be made lighter.

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[1] At Isandula the magazine-rifle would have been invaluable.

[2] At the Alma the Highlanders reserved their fire until within charging distance of the Russian squares and columns.

The CHAIRMAN: As a matter of fact, they are made lighter.

Captain CURTIS: It is impervious to rust, I suppose.

Captain LUMLEY: One drawback to this rifle is, that the English Government would never adopt it, being a bolt-rifle; our Committees have always been against this kind of breech action. I have been before several Committees, and have lately seen a good many of these rifles, and the conclusion I have come to from what I have heard from Officers is, that the English Government is decidedly opposed to any bolt-rifle, and unless they can obtain a repeating rifle on the block system, they will not adopt one at all, on account of the great expense of an entirely new rifle. Naturally, as a block moves up and down it is very difficult to transform these rifles into repeaters without one motion of the hand; but I have seen lately a rifle, the Henry-Martini, converted into a repeating rifle, where this necessity was done away with; but on further examining it closely, I found the power of the extractor was affected. I fear if we are to have a repeating rifle in England, we shall have to adopt the bolt system and have an entirely new rifle.

Major ARMSTRONG: Before I make a rejoinder to the points that have been raised one by one I should like to state this. Of course I presented the arm to you as it stands on its own merits, but it consists of two perfectly distinct principles, the bolt system and the magazine; I am aware that there is a very strong theoretical objection in England to all bolt-guns, but the magazine system is the important feature. I believe that it would be extremely difficult to adapt that magazine system to the Martini action. It is very much easier to adapt *any* magazine system to a bolt-gun than it is to a breech-block system. Certainly it would, I believe, be very difficult to adapt this one to the Martini-Henry. The important feature seems to me to be the magazine system. The gun is very simple and strong, and can very well stand on its own merits. I am not able to say if it is the best form, but the magazine system is the great feature. As to the weight of the magazine, which has been stated to be 4¼ ounces empty and 11¾ ounces full, I presume the five live cartridges would be of about the same weight as the dummy cartridges. I did not bring any live cartridges for fear of accident, but I can put some at the disposal of the Institution. As to the cost of the magazine I should say it would be a couple of pence only. When we come to deal with thousands of arms, these two points, the cost and the weight, are certainly important, but against the weight you must set off the advantages which this gun possesses as a single-loader. It has not got the fixed, immovable, unalterable weight of the magazine system in other magazine-rifles.

Captain CURTIS: You do not always carry the weight of the magazine and rifle.

Major ARMSTRONG: The rifle, other things being equal, is only the weight of an ordinary breech-loader. It may be made any weight you like in the manufacture, and until you attach the magazine it remains a simple single-loader, In any gun with a fixed magazine you must add the weight of the magazine action, so that the weight of four or five of these magazines in which the reserve ammunition is served out to the individual soldier is probably, other things being equal, counterbalanced by the extra weight in another magazine-rifle of its magazine system.

Captain LUMLEY: You carry the weight in your pocket instead of on your shoulder?

Major ARMSTRONG: Yes. You do not carry the magazine in your pocket on the magazine system; I am speaking now of other magazine-guns.

Captain LUMLEY: There are some other magazine-guns on the same principle.

Major ARMSTRONG: Of what are the magazines made?

Captain LUMLEY: Tin.

Major ARMSTRONG: It becomes a matter of practical experience whether the tin is to be trusted. Captain Curtis alluded to the additional grip, which would be, perhaps, of more importance in a sporting gun, which would be naturally shorter than a military gun. With a long gun like this the man would need to have the support of his left hand thrown well forward. With a sporting gun it would be an advantage, it would give a stronger grip to the left hand.

Admiral BOYS: I should like to ask whether this system of magazine is not

adapted to several other descriptions of bolt-guns, magazines precisely of that nature?

Major ARMSTRONG: I do not know: the arm as it stands now is patented in every European country and in America. There are some similar magazine systems adapted; I have had very little experience in these matters theoretically or practically, but I do not myself know of any in which the magazine is attached exactly in this position. The Burton is one in which the magazine is attachable at the side and projects very awkwardly, the cartridges as far as I can understand being dropped into action as required by their own weight. But that magazine as far as I could judge was necessarily very much more solidly fixed than this system requires, in fact it appeared to be a solid part of the gun. I had not, however, an opportunity of handling or working it.

Mr. BURTON: I would like to explain with regard to my gun, that the hopper is not a permanent fixture, as stated, but is made to be carried on the soldier's waist-belt, and it is capable of being applied or removed at will in less than 10 seconds; this hopper carries 10 cartridges, and when fired off the hopper can be re-filled in 10 seconds. Another of my improvements consists in packing the cartridges in tin boxes of ten each, "tin boxes being as cheap as paper." A short hopper is placed on the gun, which owing to its size may be made permanent, or, like the former, removed at will. The lid of the tin box is removed, and the tin box placed in this hopper, mouth down, when the cartridges feed down by gravity into the gun as the preceding one is fired off. When all the cartridges are fired off, the empty case is removed and thrown away. Another full box replaces the spent one; to do so requires not more than a few seconds. Those hoppers are made of steel, and so strongly secured to the gun they cannot be broken off by a blow of a sword. The latter hopper carries five cartridges, and one in the barrel; if used independent of the tin boxes, it stands but little above the gun, and does not interfere with the manipulation of the gun. I wish to say that the Lee gun before us is an infringement of my patent, and cannot be made without infringing my patent.

Major ARMSTRONG: I am glad to hear your first remark, and sorry to hear your second, but as I said I have no theoretical, and but little practical experience in these matters. I saw your gun once, but I never handled it that I am aware of.

The CHAIRMAN: Before we close the subject I should like to make a few remarks. The objection to the bolt fermeture for rifles appear to be quite confined to England. I do not see that we are called upon to adopt that objection. It is principally caused by the number of accidents that have occurred in catching the bolt on closing the breech. The firing spring is caught on a little catch when drawn back, and the catch is transferred to the trigger lever on closing the breech. In making the transfer the gun is apt to go off, but that does not occur very often. Bolt-guns are of various kinds, and in some this difficulty has been overcome. Of course we have seen the Lee magazine adapted to several other guns, but we cannot here go into the question of patents, it is far beyond our province. This magazine has lately been made lighter; it has been made of ebonite, and in the United States it has been made of paper, and I believe I am right in saying they have reduced the price to about 1½*d*. They are so cheap that they may in action be thrown away after having been used. Of course at general exercise you might retain them for re-filling. The weight is of course a consideration; it adds about a pound to your magazine. This is an addition, but you must have magazines for your magazine-gun, but generally you have one magazine, which is re-filled from the pouch, and here for your fifty rounds you have ten magazines. This is no doubt a drawback. I should like to know whether these are exact models of the cartridges.

Major ANDERSON: These are exact models of the United States Service cartridge.

The CHAIRMAN: It is a service cartridge manufactured for the purpose of avoiding the difficulty which you mentioned; the cap is so thrown back that the point of the bolt does not catch it.

Major ANDERSON: There is no cap in it. The cartridges rest in the magazine, so that the bullet in one cartridge never touches the cap of the other.

The CHAIRMAN: These cartridges are, I believe, constructed with the express purpose that the bullet shall be in the recess, in order to obviate the danger of

ignition from the point of one cartridge striking the cap of another in tubular magazines.

Major ANDERSON: I am not quite certain about that; it is the United States cartridge.

Mr. BURTON: I would like to call your attention to this cartridge I hold in my hand, which I wish you to examine; it is so constructed *that all danger from premature explosion is entirely overcome*, it can only be ignited in the gun, or unless struck by a blow by a pointed instrument, through the hole in its base. It may be re-loaded like others, the cost is the same. All my efforts to induce the Government to adopt it failed; they would not even consider it, as it did not emanate from Enfield.

PAULSON'S ELECTRICAL AUTOMATIC LOCOMOTIVE TORPEDO.

By Mr. R. PAULSON.

BEFORE I enter into the subject of my paper I must ask the members to indulge me for a few moments. I feel that I address this meeting rather at a disadvantage. In the first place I am a stranger, and, therefore, should I unwittingly transgress any of your rules, I hope due allowance will be made. Secondly, the subject I am about to deal with requires rather careful handling, and I feel rather at a loss how to proceed when I stand before you to describe a weapon in only a broad, imperfect, and crude manner; for although I am fully prepared under proper conditions to prove that the assertions made in my paper can be carried out in detail, still for obvious reasons it would not be good policy on my part to disclose those details, a torpedo being a weapon that can be and is made secretly.

In commencing my paper I must tell you that I make three distinct torpedoes. One of these, very small, simple in construction, and cheap, 12 feet long by about 12 inches in diameter, used for the destruction of an enemy's mines or in case you want to enter a harbour. This torpedo can be steered automatically, aided by clock-work, so as to run for a certain distance in a straight direction, then to go serpentine or in circles until it comes within the attraction of a mine, when it will be steered towards it, and will explode on contact; I do not propose to put any engines in that torpedo.

The second point of my invention refers to improvements in constructing and working the Service torpedoes. The apparatus weighs about 7 or 8 lbs., and will automatically steer a torpedo in any direction. It may be fitted to the present Service or Whitehead torpedo, and also to submarine or torpedo-boats, and I claim that aided by this and *other* improvements, the speed will be increased about 25 per cent., the explosive power used, although the same weight for weight, is quite as safe, but fifty per cent. stronger. This I have proved in a very simple manner. I have also two systems of overcoming the protection provided by nets, that can also be fitted to the Whitehead or other torpedo.

The third torpedo is the one which I make about 25 feet long, and is used solely for coast defence. This weapon travels at a greater

speed than has yet been attained by any torpedo, it carries more motive power, and also a very destructive explosive, very powerful but not too powerful, that is to say, not so destructive that it might injure friendly torpedo-boats that happened to be too near, because if too large a charge were used it might crush in the sides of a submarine-boat, but it would still be sufficient to destroy the largest iron-clad. This torpedo may either be steered automatically or controlled from the shore part of its course.

The cost of the small torpedo to which I first referred is about 100*l*., and the cost of fitting my complete arrangement to the Service torpedo would not exceed 15*l*. I will now proceed to more particularly describe the improvements. The working pressure can be increased to 1,500 lbs. per inch, which is also maintained during the entire run; when the torpedo is checked or nearly exhausted it comes to the surface. This improvement can also be applied to the Whitehead and other torpedoes.

Another of the principal features of the torpedo is the arrangement by which it steers itself automatically in any given direction, in a direct line, independently of its being launched straight, and of adverse currents, or of any deflection accidentally caused. In carrying out this arrangement electric contact is made through and by means of a suitable compass. Now I am well aware that to merely make such contact so as to ring an electric bell has been done before, but on trying that system I found it did not answer at all; it had to be greatly improved, and what I claim in my patent is the automatic steering of torpedoes, which has never been done before. Other torpedoes have mostly been steered or controlled by wires from the shore, but automatically never. This torpedo also carries a battery, the negative pole of which is placed in connection with the coils of two sets of electro-magnets from which leads are conducted to two metal pins fixed on a disc of insulating material. The other pole of the battery is placed in communication with a balanced magnetic needle of special construction. The metal pins are placed one on either side of the needle, and the course of the torpedo having been determined and set, it is started. Any deviation of the torpedo from its assigned course causes a relative movement of the needle which touches one or other of the pins, thus establishing the circuit through the coils of one or other of the two magnets. An armature connected with the rudder is attracted, and by this means the torpedo is again placed in its right course when the contact is broken. Any deviation from the right course in the case of the controlled torpedo is immediately indicated to the persons so controlling it, and also its course from time to time.

[Mr. Paulson now explained, by the aid of the model before the meeting of a small bronze torpedo about 30 inches in length, mounted on a swivelling stand, with electric wires and a bell, that any deviation from the course the torpedo is set to run was indicated by the ringing of the bell. Each blow on the bell would represent the deflection of the rudder, and the continuous ringing of the bell indicated that the rudder was set hard aport or starboard as the case might be.]

PAULSON'S IMPROVED OR AUTOMATIC TORPEDO.

Horizontal Section.

AA. Screw propeller. B. Propeller shaft. CC. Horizontal rudders. DD. Fins. EE. Electric magnets. F. Engine. G. Secret chamber. HH. Batteries J. Steering compass. KK. Studs connected with electric batteries HH and electro-magnets EE. MM. Motive power chamber, 1,500 to 2,000 lbs. pressure. NN. Explosive charge. OO. Smaller charge for breaking nets. PP. Triggers.

One very important point is the compass. Its power of attraction must be much greater than the ordinary compass; that was a very difficult point to deal with. The magnet in the first instance was made very heavy; then I found the friction on the point, when suspended, was so great that the earth's magnetic force was not sufficient to properly work it. There were many similar difficulties that had to be overcome before a compass was obtained that would perfectly answer the purposes required. The outer case of the torpedo may be partly made of compressed strong waterproof paper or fibre, and is thus not affected by climatic changes or long storage. The construction of the various other parts is extremely simple. The battery can be stored any length of time; it weighs under 2 lbs. and will last about two hours without recharging, giving off 8 volts, or it will keep a small electric lamp glowing for that time. This automatic steering arrangement can be also applied to unmanned torpedo-boats or submarine vessels generally.

With regard to the protection afforded by torpedo nets, in my patent I show a small charge, about 10 lbs., carried in front of my torpedo; that is also a speciality that I claim. I am told that a torpedo fully charged has been fired to test the best nets in use in the Royal Navy, and the result was that a hole 40 feet in diameter was made in the net. I am also told that if you *merely suspend* 33 lbs. of gun-cotton on the present Service torpedo nets, it will not destroy, but only bulge them out; that is because it was merely loosely suspended. But if you have 10 lbs. of gun-cotton in front of a torpedo travelling 25 knots an hour, the result would be to cut the nets, even though they were almost as thick as a cable, as they would not then be loose, but made taut from the force of the blow given by the torpedo itself and at the moment of the explosion. The range of the torpedo, as I improve it, is from 1,000 to 2,500 yards, and its speed 25 to 30 knots. It travels almost noiselessly through the water, and the depth can be accurately and uniformly regulated. The counter may be so adjusted, if required, that should the torpedo fail to strike the object, it can be made to return to the starting point without risk of exploding. Besides steering automatically, it may also, if desired, be controlled by means of a wire, somewhat on the Lay plan, from a torpedo-boat or from the shore, for part of its course, and liberated when within easy striking distance of the object, the operators being quite out of the range of discovery by the enemy's electric search light.

[Mr. Paulson also explained that his torpedo defies capture by any of known methods. It may be fired from any open boat or from the the shore (without a torpedo-boat), rendering it therefore valuable for coast and harbour defence; also for the protection of our Colonies and coaling stations, as it does not, moreover, require specially trained torpedo Officers for the work.

It was also stated that a torpedo upon this principle has already been made and fired on the Norfolk coast, when most of the results now enumerated were ascertained, and several distinguished and experienced naval Officers, who have had the invention explained to them, have expressed themselves highly pleased and satisfied with its merits.]

Captain CURTIS: I wish that some of our younger Officers were here who are acquainted with torpedoes. I have not been afloat with them, but I understand Mr. Paulson to say that they may be either automatic, or controllable from the shore. Do I understand, in the first place, if you want to go north, you put that indicator north, and the torpedo is supposed to go on that course irrespective of any wire?

Mr. PAULSON: That is so.

Captain CURTIS: After it has once started, you have no further contro over it.

Mr. PAULSON: No further control.

Captain CURTIS: I think that is a very doubtful advantage. You tell us that if the torpedo does not hit the ship, it comes back again by some kind of attraction. I understood that if it missed the ship, it took a devious course, and came back to the vessel again. I also understand that if it does not strike the ship, it remains afloat. I think it would be very awkward for you to cruize amongst your own torpedoes, because you might come against one of them, and it might explode. I understand that there is some magnetic attraction between that torpedo and soft iron. If so, that attraction must be very great to overcome what we call the deflective wave. I recollect when I was a youngster I tried to get ashore at Mont Junk at Barcelona; the water was very deep, and really you could not get the dingy alongside the shore; the deflective wave drove the boat off, and you had to be pretty smart when the boat took the rise in order to jump ashore, because the boat was repelled back. I have heard of a case where a ship was saved from a rock off Cape Doro, in Greece, by the rebound of the wave; it is very often the case that the rebound sends the ship back. We often hear of people being drowned, although they can swim, because they cannot reach the shore, on account of the reflux wave, note particularly at Dungeness. I was going up the Channel on one occasion, when a man with delirium tremens jumped overboard; the paddle-wheel came down, and instead of sucking him under, according to popular idea, the water which was deflected drove the man away. I was so interested in this, that next day I got several empty bottles, and I could not by any means get the paddle to go over any one of them, they were all driven away by the deflecting wave. I believe Officers say that if a ship is going 14 knots, and a torpedo-boat is going 19 knots, the proper mode is to attack her bow, because in that case the torpedo-boat will be less likely to be under continuous fire. But there is another way of looking at it; if you fire on the quarter of a ship, the following water will suck the torpedo under, but a boat coming up on the quarter or stern will be under continuous fire. With respect to this deflective wave, the French say that at their torpedo experiments all the torpedoes struck, but we were also told that the weather was very calm, and that the state of the sea was not to be compared to Bantry Bay during the experiments there. I did hope that we should hear some lecture from our Chairman with regard to Bantry Bay, but whether it is intended to keep the information there acquired a secret or not, is best known to those concerned. It was stated (I believe this is no secret) that the "Polyphemus" had her nets out when she attacked the boom.

The CHAIRMAN: That is so.

Captain CURTIS: There is no doubt that the net is the cheapest protection you can possibly have, but although a net can break up a sea, it cannot stop a sea. It is just the same with your cable; you can break the cable because of the resistance that it gives, but a torpedo-net gives less resistance, and yields. It is a well-known mechanical principle that a thing may yield, and you cannot blow it up, whereas if it offered more resistance you would break it up. There is no doubt that this is an extremely ingenious invention, but I do not see after you have set the indicator north and south, as the case may be, that you have any control over it. There may be something in the attraction of a ship, but you may depend upon it that the deflection of the water, and the force of the water, is something terrific. I believe hat the transmission of force through water is almost simultaneous with the force tiself, because it travels 600 yards in a second of time, as quickly as sound. At the earthquake in the Straits of Sunda, it was found that the earthquake wave travelled at the rate of 1,250 miles an hour, and that is one of those things that naval Officers

should take into consideration. When I was afloat, we knew very little of the theory of turning ships, and so forth, but Captain Colomb has made a study of this, and has reduced it all to writing. When I was afloat, we were not allowed to have the courage of our own opinions; our superiors always knew better than we.

Mr. PAULSON: I may say in reply to Captain Curtis that he is quite correct in saying that if you set this torpedo on a given course, after it has left your hands you have no more control over it. The torpedo is automatic in all its details, unless it is controlled by a wire. But if I set her north, and she travels north, I can set the counter that regulates the distance and cut-off valve, so that it will turn the compass-card south; electric contact will then be made until you get the torpedo's head south, and this causes it to return to its starting point. Now, gentlemen may understand what I mean by "returning on her course." Or this can easily be done by clockwork; I can set a clock inside, and so arrange it that the torpedo shall travel say 1,000 yards in so many minutes and seconds, and then be made to return as before. If she has passed the vessel aimed at, the counter might be made so as to put a safety-bolt between the projecting trigger and the charge, so that if she struck in returning one of her own vessels, an explosion would be prevented. It simply shoots a safety-bolt, just in the same manner as pushing a safety-bolt on the lock of a gun. There has been a good deal said about attraction. I do not know whether H.M.S. "Polyphemus" did deflect the torpedoes at Bantry Bay. I have not proved whether the attraction of an ironclad would be sufficient to deflect my steering compass, and thus the torpedo; some naval Officers have expressed one opinion, and some another.

Captain CURTIS: The suggestion was ignored in this Institution by a torpedo Officer, who would not take it into consideration at all.

Mr. PAULSON: Then about the nets; I maintain that so long as a net is perfectly loose, it would be very difficult to get through it; but when you have a torpedo weighing 500 lbs., the force of that torpedo would stretch the net, and make it as taut almost as if it was a cable. Then it could be cut even by the explosion of a very small charge of guncotton, as a thick wet blanket which if loosely suspended will stop a bullet. Something was said about the vessel's speed deflecting torpedoes. I should say a great deal depends on the shape as well as the speed of the vessel. I know the "Polyphemus" went about 18 knots, but I should be surprised to hear she could do anything like that speed when she had her nets out. I am well aware that water will transmit power, and if you explode guncotton under water, you may feel the shock a mile or a mile and a half off. A gentleman told me the other day that he had got some guncotton, and as the acid made it rather dangerous, he took it down to the Thames in order to get rid of it. He said there was a vessel nearly a mile off, and after the explosion she signalled to him that some of her plates had started, which made her leak. The gentleman said he did not believe it, but anyhow they seem to have felt the shock. My own belief is that if Mr. Nordenfelt exploded his torpedo and 300 lbs. of guncotton under water, his own submarine boat would, if anywhere near, be completely crushed up. I need only now, in conclusion, thank you very much for the kind attention you have given to the subject, and hope that you will pardon me for having detained you so long.

The CHAIRMAN: The lecturer has just alluded to the area of explosion. I should be glad if he can tell me whence he gets his dimensions of the area of explosion.

Mr. PAULSON: From Professor Abel's own reports. You will find them all published; they are approximated over a given distance.

The CHAIRMAN: I was with Professor Abel at the time these experiments were carried out, and half-a-mile is far beyond anything that he attained at the Spithead trials. The area of explosion of torpedoes is in the form of a very oblate cone. It sometimes extends horizontally for 300 yards at the bottom of the sea, but it comes to a very fine point on the surface, so much so that a boat 20 feet off is quite safe. The torpedo explodes, and the column of water is thrown up through a very small opening in the surface of the water. The explosion seems to have a double effect, at first when the torpedo explodes a narrow column of water is thrown up 60 or 70 feet. Then if you watch you will see a second but much broader column of water come to the surface having a diameter of from 40 to 50 feet.

This is the rebound of the wave against the bottom, and the rapidity with which it follows the first column depends on the depth of water. It is with this second wave that all the dead fish and the mud comes up, the first one being perfectly pure. The wave from the ship's bows which affects the torpedo is not an imaginary thing. If you fire a Whitehead torpedo out of the bows of a vessel at an angle of 7° on the bow, if it is a certain height above the water the bow of the torpedo enters the water first. You see the wave take the bow, throw it off from the keel line, and then as the stern takes the water afterwards, the stern is thrown round, and thus generally directs the torpedo nearly right ahead. In the same way if you fire right ahead with the Whitehead broad from the bow it drops into the divided waves, this wave first carries the bow round, and then carries the stern round. It will come round about 5° in the opposite bow; that shows the wave does affect it, but if the stem and stern enter the waves simultaneously the deflection will not take place. The power of compressing fibre is a very well-known fact. Compressed fibre is now used in the United States for the tires of railway carriages. It is compressed at something like 9,000 lbs. to the square inch, and stands a great deal of wear. I do not think it has been made sufficiently thin to construct a torpedo of, but I do not say that such is an impossibility. As regards holding a wet blanket up before you, I never met any one who ever held a wet blanket up before him, and allowed any one to fire at him through the blanket, and I rather think that if any one tried it I should not meet him again. The attractive power of ironclads enters into a great number of people's heads. The formula for attraction is as the cube of the distance, and therefore you may imagine that a very little way off from an ironclad there would be no effect whatever on a compass. Although the ironclad is a very powerful magnet, yet you may safely say at 120 yards it would not affect any compass whatever, or even the most delicate electrical instrument. I will not take up any more of your time, but I think you will all join with me in thanking Mr. Paulson for his interesting paper.

ELECTRIC GUNS AND AMMUNITION (RUSSELL'S PATENTS).

By (the late) W. Seyton.[1]

The application of electricity as a means of igniting gunpowder in the cartridges of small arms is not a new idea. Several patents have been taken out for this purpose during the last twenty years, not one of which has been hitherto found to be of any practical use in the field.

Prior to the dates of the patents of Dr. Russell, the inventions embodying the use of electricity in military and sporting guns have been of two classes.

In one the cartridge contains a platinum wire, one terminal of which connects through the barrel and breech with one electrode of the battery, while the other electrode is connected to a sharp needle or firing pin, which when pushed forward by the pull on the trigger, or pressure on a button, penetrates the cartridge and its charge of powder until it touches the other terminal of the platinum wire, thus completing the circuit and firing the gun.

[1] Mr. Seyton was killed the following week, being shot through the heart by an unintentional ignition of an electric cartridge.

In guns of the other class the cartridge has two exterior contact terminals upon its base, both insulated therefrom, which in loading the gun have been made to touch respectively two corresponding contacts on the breech-block of the gun, the latter forming the terminals of an open circuit to be closed by a push-button or key in order to fire the gun. These inventions, however ingenious, are impracticable, often unsafe, and the battery arrangements and connections cumbrous and complicated.

The object of the Russell patents is to provide an electric gun which shall be practicable for ordinary use, and, while retaining the external form characteristic of the ordinary gun, to be simple in construction, certain in its action, and entirely free from danger.

With this view the firing pin is made to touch the centre of the base of the cartridge, instead of penetrating it, and the breaking of the circuit and locking of the trigger is provided for automatically, so that the gun cannot be fired after being loaded until the trigger has been released by a distinct preparatory movement.

The electricity is evolved by means of a small battery in the gun, and is communicated in a simple and effective manner to the igniter in the cartridge shell.

While maintaining the exterior form of the present arms, and also the trigger, firing pin, chamber, and extractor, several parts of the internal mechanism are done away with, including the mainspring and hammer, but the same form of shell is used as in the percussion system, the electric primer being simply substituted in the place of the cap.

The change in the shell for use in the electric system by the substitution of the igniter for the percussion cap is made at small cost, and as the igniter is not destroyed or displaced by repeated firing, it has been found to have practically the life of the shell.

The advantages of this system, besides that of economy, are as follows:—

1. *Safety.*—The cartridge is rendered absolutely safe by dispensing with the use of fulminate employed in the ordinary cap. This consideration is most important in single-loading arms, but for repeating arms it is vitally essential, as all danger arising from cartridges resting upon each other in the magazine is wholly prevented. The risk in transporting and handling cartridges is also done away with.

2. *Certainty and Perfection of Fire.*—Perfection in the making of the present percussion cap can only be proved by its explosion, whereas each igniter can be tested before the shell is loaded.

As the igniter can be extended any distance into the shell, the powder is lighted over a larger area, the entire charge is more completely burned, and more force to the explosion secured.

3. *Greater Accuracy in Aim.*—The mechanical force employed in pulling the trigger in existing arms is a cause of inaccuracy in aim, which by this system is wholly done away with.

4. *Non-corrosion.*—It is well known that the firing of the fulminate in the cap is injurious to the chamber and barrel by reason of its corrosive effect; this is wholly avoided by the use of electricity.

5. *Effect on the Shell.*—The life of the shell will be considerably lengthened by the avoidance of the strain caused by the expansive force of fulminate, and the necessity of re-forming the shell for repeated use will be lessened.

The continued improvements in the manufacture of sporting and military guns—the changes from the flint lock to the percussion cap, and from that to the central fire—seem to find their fitting climax in the electric system as now perfected in these inventions, which give the power to have within the weapon itself the source of ignition for many thousand rounds, and in the shell the medium for its use without any change in the external form of the weapon as at present constructed.

The generator or battery is simple, solid in construction, and conveniently placed in the butt of the gun. From actual experience as many as 15,000 ignitions have been obtained from one battery without any change of the elements, and extreme alternations of temperature seem to have no effect on its efficiency. An average of 5,000 to 7,000 is therefore considered a safe estimate of the number of shots that can be fired from an electric gun or rifle without change of battery.

The conditions of economy, perfection of fire, and safety in the use and transportation of guns and ammunition are specially called for in military weapons, and it is believed that all these benefits have been attained in these inventions.

The system has been put to very severe and exhaustive tests in the United States, principally by Captain S. A. Day, of the United States Army, who is well known as an authority on the subject of army weapons, and has had much experience in their use and knowledge of their construction.

The following reports from him are of interest. Some of his remarks refer more especially to sporting guns, but with few exceptions they are as applicable to rifles as to fowling-pieces.

Report of Captain S. A. Day, U.S.A.

Port Hamilton, New York Harbour,
September 8th, 1884.

When the system of ignition for small arms under consideration was put in my hands for test June 23rd last, I was able to state to you at once some of the obvious advantages of substituting electric fire for percussion, provided it could be accomplished in a manner to meet every practical requirement.

To be an important and prevailing success, however, it would need to give these advantages in the present highly perfect sporting and offensive arm without failing in any requirement for their best use. It seems entirely probable that the present generation at least will continue, not only to fire with the accustomed trigger, but will adhere to the special pattern of arm which the individual finds reason to prefer.

The obvious advantages of electric discharge may be stated in the probable order of their importance, viz.:—

1st. The absolute safety of cartridges containing only a metallic igniter in lieu of the fulminate for percussion.

This in itself might give ample reason for the change of a system; it eliminates the fear of danger in magazine-guns, otherwise growing so rapidly in favour, and it

abolishes the risk attending the loading, transporting, and handling of ammunition containing fulminate.

2nd. It is indisputable that the power of igniting charges of long proportions at any desired point along the central line instead of the base, as with percussion primers (or even at the wad as in the needle gun), gives the facility to burn the entire charge, and under better conditions of using the expansive force. The exact point of ignition for best results should vary with dimensions and form of charge; but the power to determine at will the point at which ignition shall take place, and vary it, is given by this method. With the uniform precision of an electric point, an exactitude of performance, and an economy in producing given results, are secured, not heretofore possible, with any percussion fire.

3rd. Electricity can dispense with the disturbance of aim, incident to the necessary mechanical force in use of hammer and heavy springs to explode fulminating primers or caps. This source of inconvenience has not been duly considered, as there has seemed no way of avoidance, but it will be thoroughly appreciated when compared with a more perfect substitute.

The mode of electric fire submitted to me by you consisted of an electric igniter or primer of any desired appropriate length inserted in an ordinary metallic base shell to form the electric cartridge for breech-loaders.

Also a current pattern of breech-loading gun with a small generator concealed in the stock, and firing device replacing hammer and springs, and responding to the trigger, necessitating no change in the exterior form or apparent action of the gun.

For more than two months my critical attention has been given to the principles and practice of the methods in the gun with its ammunition. I have found no objection to raise to its entire practicability—the work is better done than by percussion locks, and the advantages appear.

It would be unwise, in scientific progress, to say what can or cannot be done in the future, but I can say that the limits of simplicity seemed to have been reached in the use of electricity in this invention. Fewer parts (and consequently less expense or element of uncertainty) could hardly seem possible, and I am not aware that the results can be satisfactorily produced outside of the methods of this invention.

With proper knowledge and mechanical skill I see no reason why the method cannot be introduced into any of the improved small arms in use (above the size of a pistol), and with excess of room from the elimination of cap-striking machinery. Having a familiarity with most of the approved arms, I know of none to which I believe I could not myself introduce this electric method without interfering with the other characteristics of the arm.

I have made the electric primers for my shells (thus forming the cartridge of this invention), and they do their work perfectly, with this additional convenience, that the primers have not been destroyed or displaced by repeated firing. Therefore there is no de-capping or re-capping necessary for brass shells. I have kept them in continuous use without change, and the primer seems to have the life of the shell.

Another marked convenience attaching to this electric ammunition is that the perfection of the primer can be tested before loading the shell, in a second of time; whereas with percussion primers to test is to explode, and an imperfect construction is only known by the loss of a shot.

The electric generator or battery is of simple solid construction in one small substantial case, readily inspected or removed at will through the heel plate. Several exterior forms were furnished, and I have given my opinion as to the most desirable; but none of them occupied sufficient space to weaken the stock of the gun.

I see no occasion for the disturbance of the functions of the generator by any proper use of arms, or other than by accident, that might otherwise disable a gun or fracture its stock.

I have used several of these generators, and I see no scientific reason to doubt the statement of electricians that from 5,000 to 20,000 ignitions, depending on the construction, can be made without replacing the elements, and that long periods of

disuse require no more care or expertness than is necessary in care of an ordinary percussion lock.

The sum of my criticisms is, that this substitution of electrical discharge stands the requirements, and therefore gives the advantages over percussion first named.

It remains to apply the skill in the adaptation of this method to other standard patterns of small arms to enable this ammunition to be fired by their triggers, and the world at large will have the opportunity of experiencing the superiority over percussion.

I came to the subject with the conviction that electric fire would at some time supersede the clumsier mechanical modes; but nothing before presented, here or in Europe, has attracted attention as even claiming to fill what I consider the absolute requirements of use with modern arms.

Now I find myself, with permission, adopting this use in my own favourite guns. I hope, as time will permit, to give you some comparative records.

I remain, gentlemen, with respect, yours, &c.,
(Signed) S. A. DAY, U.S.A.

Martini Rifle (Electric).

In another report dated Fort Hamilton, New York Harbour, he says:—

June 8th, 1885.

I have just finished the test of the Martini Military Rifle submitted, and have the honour to make the following report:—

The gun worked well in every respect.

One primer seems to have been destroyed at the tenth fire, all of the others, though repeatedly fired, are still in working order.

The double in the pull on the trigger in this gun I regard as a particularly good feature, allowing, as it does, for the most careful correction in sighting at the last instant.

The battery, as well as the other parts of the gun, worked well, and on inspection after the trial is found to be in perfect order.

The charges used were 80 grains powder and 480 of lead in the bottle-necked shells. There was no escape of gas around the primers and very little at the mouth of the shells.

The recoil and general shock of the piece seems to be less when fired by electricity, using the same charges, than when percussion is used, and the results were more uniform.

With uniform primers I think the gun can now be safely submitted to a field test.

Very respectfully and truly yours,
(Signed) S. A. DAY, U.S.A.

The following memorandum of a trial of the electric fire in double-barrelled guns made last summer may be of interest as showing the result of continuous firing on the electric primers in brass shells.

Memorandum of Trial at the Parker Brothers Arms Manufactory.

Meriden, Connecticut,
July 17th, 1885.

(To be an exhaustive test by Gun Manufacturers.)

Guns taken, Colts double-barrelled and Harrington double-barrelled. Batteries, one that had been four months in gun, one two months, and one new. The oldest had already made 5,000 ignitions, and the second, say 2,000. The entire testing was made with the older batteries.

Present, the Superintendent and Assistant of Manufactory, the Assembler, and the Chief Salesman, who is a noted wing-shot. All were critical experts, and all participated in the testing, which was entirely in their hands and not limited as to its character.

The examination lasted some five hours, the barrels being at times cooled in water to save time.

The firing was at flying objects, and some of the cartridges were dipped in oil, and otherwise the treatment was severe and unsparing.

The guns never failed or flinched in their work, excepting that one primer point failed. This fault was definitely located to the primer (and not the gun or battery), and was not considered by them as noteworthy, in consideration that the manufacture is new and not systematized, or in practised hands.

Captain Day also sends the following:—

REPORT OF COMMENCEMENT OF COMPARATIVE TESTS OF ELECTRIC FIRE WITH RIFLES, ELECTRICITY AND PERCUSSION BEING ALTERNATELY USED THROUGH SAME BARREL, IN RIFLE CONSTRUCTED TO FIRE WITH EITHER.

Fort Hamilton, New York Harbour,
July 21st, 1885.

I enclose two targets made yesterday with the Hotchkiss Military (Bolt) Rifle, and which tell their own story as far as it goes.

They were made with the same gun, elevation of sight, hold (as near as could be) ammunition, &c.

The bolts being exchanged for alternate shots, so that the conditions of weather, wind, fouling of the gun, &c., should be as near the same as practicable.

The better score made by the electric fire I attribute somewhat to the pleasanter and, of course, better pull of the trigger in the electric bolt, and which we know is a big thing in fine shooting.

But the points of importance are the evenness of the elevation kept in the electric as compared with the percussion, and as shown in the graphic illustration by parallel lines on the margin, and the mean height of the shots on the target, and which proves as far as it goes a flatter trajectory, or greater velocity, due I think to the central ignition by electricity.

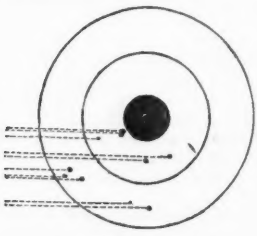
This too was accompanied by much less recoil of the piece and a softer report, a total of good results that I hardly hoped for.

It is sufficient I know that my name is signed to the transcript of the targets, but the experiments were made in the presence of, and under the careful observation of another Officer of my regiment, Major Brinckle.

Yours respectfully and truly,
(Signed) S. A. DAY, U.S.A.

At *Fort Hamilton*, N.Y. Harbour,
July 20th, 1885.

Gun—Hotchkiss, Milt. Cal. 45. Percussion.
Am.—70 grs. powder, 500 lead.
Elevation—275 yards.
Distance—300 yards.

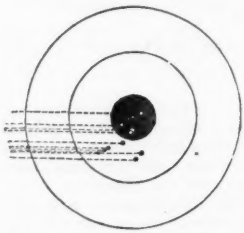


Score—4, 4, 3, 3, 3, 4, 4, 3, 3, 4. Total, 35.
PERCUSSION FIRE.

S. A. DAY, U.S.A.

At *Fort Hamilton*, N.Y. Harbour,
July 20th, 1885.

Gun—Hotchkiss, Milt. Cal. 45. Electric Fire.
Am.—70 grs. powder, 500 lead.
Elevation—275 yards.
Distance—300 yards.



Score—5, 4, 4, 5, 4, 5, 5, 4, 4, 4. Total, 44.
ELECTRIC FIRE.

S. A. DAY, U.S.A.

Major ARMSTRONG: I should like to ask one question. Am I to understand from the diagram that the yellow pin marked A in the upper diagram is supposed to carry the ignition into the cartridge itself?

Mr. SEYTON pointed out the cartridge and the igniter.

Major ARMSTRONG: Is that the exact length?

Mr. SEYTON: You cannot make it any length.

Major ARMSTRONG: Because it seems to me that that is one of its most important features, that the ignition can be taken very much further forward.

Mr. SEYTON: It can be taken any length you like.

Major ARMSTRONG: I think there is no question about it, the ignition is better, and the result is altogether better if the ignition takes place at the base even of the bullet.

Mr. SEYTON: That is Captain Day's opinion, and that is the opinion of most of the experts I have consulted.

Major ARMSTRONG: That seems to be one of the most important features.

Captain CURTIS: There is not the slightest doubt that a great deal of powder is usually blown out without igniting, but if the powder is ignited at the base of the bullet this cannot happen. When they introduced the prism powder in big guns I believe much of it was blown out unburnt. This often occurred in saluting, greatly to the danger of passers by.

Mr. MORRIS: An almost identical system with this was shown in this Institution about two years ago, by Colonel Fosbery, V.C., and was the invention of Mr. Pieper, of Liège; they are practically identical.

Mr. SEYTON: I have full knowledge of what Mr. Pieper has done. It is entirely different in the form of the shell, and in the method of firing.

Mr. MORRIS: He has a battery in the butt.

Mr. SEYTON: He has no battery like this; it is on a larger scale altogether. The butt is very much more hollow. The advantage of this style of battery is that it takes such a very small space in the gun.

Mr. MORRIS: I have seen one not bigger than a watch, the whole thing.

Mr. SEYTON: The question is how long that would last.

Mr. MORRIS: I have seen about 8,000 shots out of it.

Admiral BOYS: What is the expense of this arrangement, fitting the battery to the gun?

Mr. SEYTON: As to the cost of the battery, I estimate it would be from 8*s.* to 9*s.*

Admiral BOYS: To each gun?

Mr. SEYTON: To each gun. If they were made in quantities they would not cost more than 5*s.* or 6*s.*

Admiral BOYS: There is a fitting in the cap of the cartridge?

Mr. SEYTON: That is the igniter. I think we can make igniters with paper shells for about 4*s.* to 4*s.* 6*d.* a thousand. A better class of igniters for brass shells that would last as long as the shells, the shell being re-loaded so many times, would cost more than double. They are better made, and of better material; they would cost very nearly 10*s.* a thousand, or perhaps 11*s.*; against that you must put that they last so much longer. An igniter is not thrown away with every shot, as it is with the percussion cap.

Captain BURGESS: How long does a shell last?

Mr. SEYTON: These good solid brass shells will last 50 shots.

Mr. MORRIS: Do you know anything of the keeping powers of the ammunition, because military ammunition has to be kept in store from five to six years.

Mr. SEYTON: I could not say, because the invention is only about a year or fifteen months old.

Mr. MORRIS: That is the very trouble other inventors have had.

Mr. SEYTON: I have no doubt it would last. I have no reason to doubt that both battery, cartridges, shells, and igniter would be easy to store, and keep in as good condition as any other ammunition.

The CHAIRMAN: It appears to me the principal point in connection with this gun is the weight and dimensions of the battery. Of course what will fire a small gun will fire a heavy gun. If we can fire a gun with a small battery like that and continuously, the battery must be a very valuable one. The battery is remarkably

cheap at the price named. We do not know much of its lasting power, but if it has good lasting powers, it will be a very valuable battery. I am sure you will all allow me to return our thanks to Mr. Seyton for his interesting description of this invention.

DESCRIPTION OF PLATE.

(From S. Russell's Patent.)

Fig. 1 of the accompanying drawings is a vertical longitudinal section of the breech of a double-barrelled shot-gun constructed according to my invention, the plane of the section passing through the axis of one of the barrels and through the centre of the stock. Fig. 2 is a longitudinal section cut along the line 2 2 in Fig. 1, and looking in the direction of the arrow 2 therein. Fig. 3 is a section of the preferred form of electric cartridge to be used with my gun appended to a diagram showing the electric circuit.

The cartridge A (shown in Fig. 3) is the same as that described and claimed in another application for patent executed by me this day, to be filed simultaneously herewith. Its distinguishing feature is that the metallic base of the shell forms one terminal of the incandescing conductor, and the other terminal thereof is centrally arranged and insulated from the base.

Let *a* designate the metallic shell, and *b* the central conductor, which is a metal pin or rod, and is inclosed in a tubular insulating sheath, *c*. At its front end is connected the incandescing conductor *d*, which consists of a short piece of fine platinum wire, and the other end of this conductor is joined to a conductor, *e*, which consists of a strip of copper, which passes along the outside of the sheath *c* and joins the metallic base *a*. The base of the cartridge comes against the breech-block B, which is connected through a wire, *f*, with one pole of the battery C, and the other pole of this battery is connected by a wire, *g*, to a firing pin or bolt, D, of metal. The battery is usually placed in a mortise in the butt-end of the stock, the wires *f g* passing through a hole or holes therein to the breech. When it is desired to fire the cartridge, this firing-pin is pressed forward until it touches and makes electrical contact with the pin *b* in the cartridge, whereupon the circuit is closed, and the current in passing through the platinum conductor, heats it to incandescence and ignites the powder.

The gun is entirely hammerless, resembling externally the so-called "hammerless guns" or internal hammer-guns, and being constructed internally in some respects similarly thereto.

Let E E designate the barrels, F the stock, and G the breech. The gun is a breech-loader, and is provided with the usual fastening for holding the barrels to the breech when turned up, consisting of hooks, *h h*, on the barrels, engaging a sliding bolt or frame, H, which is operated to release the hooks by the usual unlocking-lever, I, on top of the breech. The bolt H is pressed forward by a spring, J, on a rod, *j*, as usual. The breech-block B is solid with the breech, and is formed with two conical holes, in which are fitted tubular conical plugs K K, of insulating material, which form bearings for the firing-pins D D. The point of the cone is turned towards the front, so that but a small orifice is made in the face of the breech-block. Each plug K is held in place by a ring-shaped frame, *k*, of metal, which takes against a shoulder on the plug, and is forced towards the front by two screws, *i i*, Fig. 1. Back of this ring *k* the plug K is reduced in diameter, and over it is placed a helical spring, L, which is reinforced against a shoulder, *l*, on the plug, and presses backwardly against the head of the firing-pin D. The rear surface of this head is covered with an insulation, *m*.

T T are the triggers, or, more correctly, firing-levers. Externally these are the same as on an ordinary gun, but internally each is formed with two arms, M and N. The arms M M extend up to the respective firing-pins D D, where their ends rest against the insulating-caps *m m*. When either trigger is pulled, the arm M pushes its

RUSSELL'S ELECTRIC GUN AND AMMUNITION.

FIG. 1.

FIG. 2.

FIG. 3.

FIG. 4.

FIG. 5.

FIG. 6.

HARRISON & SONS LITH. ST. MARTIN'S LANE W.C.

firing-pin forward against the resistance of the spring L until the point of the pin touches the centre of the cartridge and fires it. The springs L L serve as trigger-springs in addition to their function in retracting the firing-pins, and should have sufficient stiffness to give the requisite "pull" to the trigger. The arms N N of the two triggers extend rearwardly, and their ends are turned up, as shown at *n* in Fig. 1. Underneath the top plate of the breech is arranged a slide, P, which has a limited movement forward and backward. On this slide is an arm, Q, which projects downwardly to the ends *n* of the arms N N. When the slide P is moved forward, as shown, the end of Q does not interfere with the ends *n n*, and the triggers may be pulled as denoted by dotted lines in Fig. 1; but when the slide P is moved to the rear, the end of the arm Q comes directly over the ends *n n* of both arms N N, and the triggers are locked and cannot be pulled. This is the "safety" lock of the gun. It is operated by means of a roughened button, R, on the top of the stock, and when moved either forward or back it is held there by the spring *p* acting against a V-shaped projection, *q*, on the slide. When the unlocking-lever I is turned to permit the barrels to be broken down, the backward movement of the bolt H pushes back the slide P, and so sets the gun to "safety." This is done by the pin *j*, which moves with the bolt H, striking and pushing back a shoulder, *r*, on the slide P. After being loaded the gun cannot be fired until the button R has been pushed forward. The manipulation of the gun is thus the same as of the well-known hammerless gun before referred to.

In addition to the mechanical safety-lock to keep the trigger from being pulled, I provide as an additional safeguard that whenever the slide P is drawn back to "safety" the electric circuit shall be broken at some intermediate point, in addition to the break between the firing-pin and the cartridge. In this manner I entirely isolate the battery from both terminals of the cartridge, except when the gun is ready to be fired. On the inside of the stock is fixed a contact-stop, *t*, Figs. 2 and 3, and a spring, *s*, is attached to the opposite side, passes in front of the arm Q, and terminates with a contact-pin facing the stop *t*, as shown in Fig. 3. When the slide P is moved back, this spring does not touch the stop *t*, and the circuit is broken between them, as shown in Fig. 3; but when the slide is pushed forward the arm Q presses the spring against the stop, as shown in Fig. 2. The spring and stop form part of the wire *f*, as shown (in preference to the wire *g*), in order to break the connection between the base of the cartridge and battery.

Friday, April 2, 1886.

REAR-ADMIRAL LINDESAY BRINE, Member of Council, in the Chair.

ON THE OFFENSIVE AND DEFENSIVE POWERS OF MERCHANT STEAMERS.

By Lieutenant WILLIAM C. CRUTCHLEY, R.N.R.

IF an excuse were wanting on my part for venturing on this subject, I should plead a paper read at this Institution on February 9th, 1883, by Sir Nathaniel Barnaby, K.C.B., in which he states that "The power of waging war upon the seas depends firstly on the quality and extent of the mercantile marine in ships and men, provided that the national tie in both is real and firm."

Assuming this statement to be correct, there would be little doubt as to our maritime superiority, but on the other hand there are a vast number of competent authorities who maintain that our enormous fleet of merchantmen is our most vulnerable point, and that thus in our strength lies our greatest weakness. As with most arguments there is a great deal to be said for both sides of the question, but I shall endeavour, though in a very imperfect manner, to show that a great number of our faster vessels are an absolute source of strength, provided that care be taken in peace-time to place them in a condition to be serviceable on the sudden outbreak of war.

It is no new scheme that I advocate, it is simply a return to the old fashion of arming merchantmen to enable them to take care of themselves, but with this difference, that fifty years ago, the shipowners found the arms as freights were good and arms inexpensive; these latter conditions now having been reversed, it would devolve upon the Government to supply weapons if merchantmen are to be armed for the protection of their own commerce. As lately as 1863, I am under the impression the Admiralty were disposed to supply armaments to trading vessels, but the custom seems to have dropped into disuse during the transition period from sail to steam.

It will, I think, be admitted that the conditions of naval warfare have essentially changed, having regard to the modern steamer and the old sailing vessel. In our last great naval war, men of war or privateers were usually much faster than merchantmen, and it was a matter of almost certainty that a fast and well-found frigate could overhaul anything afloat. This condition of things has been entirely changed, and there are very few men-of-war afloat that in war-time could afford the time and coal expenditure necessary to catch a

14-knot merchant steamer. I will put the case this way: Suppose a steamer sights a man-of-war, say 10 miles off, and has no desire to be interviewed—he (the merchant vessel) is of course making his passage as quickly as he can—the man-of-war, on the contrary, is cruizing under easy steam, say 10 knots, or equal to that speed, which is a very fair allowance; by the time the man-of-war was under a full head of steam, even with all the advantages of forced draft, the merchantman would, if wide awake, have increased the distance between them to 13 or 14 miles, and the man-of-war would have to steam very fast to overtake his chase or get within effective gun-shot before dark, when a change of course or lots of things might render capture very doubtful. I am of course aware that a fast torpedo-boat might play an important part in such a chase as the foregoing, but it is at least problematical whether top speed, say 18 or 20 knots, could be maintained by a small vessel in a sea-way.

I put this case because I do not consider the risk of capture of a fast merchant steamer by a man-of-war very great. In war-time as at any other, a man-of-war would be recognized a great distance off by a number of things, no matter how he might try to disguise himself, and I need not say that in war-time he would be most piously allowed the entire visual horizon to himself, no matter what his nationality. In saying this, be it understood, I believe I am stating what would be the procedure of every merchant steamer that had heels to run with. But the foregoing remarks do not apply to fast armed vessels built for merchantmen that have been turned out to capture and do damage to their own kind; they would probably be approached with less caution, as it would not do to run from everything, and with far more disastrous effects.

A great portion of the carrying trade of this country is done by 10-knot vessels, and it is certain that the only effective way of securing these from capture would be by placing them in convoy, and protecting them by cruizers and torpedo-boats. I do not propose to discuss the question of these vessels at all, their protection has doubtless been well threshed out long ago. My remarks are now intended to apply solely to the larger ocean mail steamers. I need not particularize, and in fact I must try to keep clear of everyone's toes, or I am afraid I shall make a warm corner for myself; but I shall take as my type of vessel the one I now command: by this I mean that the arrangements I should make for her would doubtless require modification for another class of ship, but the principle would remain precisely the same. She is employed in the New Zealand mail service, and is one of a fleet of five similar vessels.

Leaving New Zealand last May for England, the greatest uncertainty prevailed as to whether it was to be peace or war with Russia. My ship was first taken up as a cruizer, and then, at the solicitation of her owners, dropped again, but the fact remained that we left New Zealand for England full of cargo and passengers, utterly defenceless, and for aught we knew war might have been declared the next day. Rio Janeiro was my first port of call, and I was very glad when I got there, so were my passengers, as I had nearly suffocated them in hot

weather when night came on by having dead-lights closed to keep the light in and hide the appearance of a floating town that electric lights fore and aft presented. I had carefully avoided all ships, and I presume I was not the only man at sea in a state of similar anxiety. The question kept constantly arising in my mind, "Why am I sent to sea in this defenceless state, entirely at the mercy of every mosquito of a ship that has the speed to bring say only one machine-gun within range?"

That was what the case amounted to: utterly defenceless, ship, cargo, and specie to the value of a quarter of a million at the mercy of anything fast enough to come alongside with the meanest armament possible, and we carrying a crew of one hundred and forty men, including three Officers of the Naval Reserve, and about twenty-five trained seamen.

Now, I presume, if England were to go to war with a foreign Power, we may fairly conclude that that Power, whichever it was, would be fairly ready to begin when war was declared, and that lines of ships coming from distant ports would be watched by the enemy's cruizers as closely as our men-of-war would let them, in the hopes of falling in with a big prize that might be useful, both as far as plunder in specie is concerned, and also as a means of committing further depredations on our own ships and commerce. The story of the wolf in sheep's clothing will explain the sequel. A vessel of English build and rig, such as the one I am speaking of, would, if she were able to intercept one or two coal-laden sailing ships, do an amount of damage that would compare very favourably with the "Alabama's" captures; she would approach our vessels unsuspected and at leisure, and destroy or capture them in detail.

There are many corners on this route—New Zealand to England *viâ* Cape Horn—where an enemy might establish a coaling station and depôt for arms and men, and where for a month or so they would be unmolested and at liberty to fit out their ships; for instance, the inlets of Tierra del Fuego and South Georgia, to say nothing of the numberless islands, out of the way places in the Pacific. I am well aware that our system of ocean surveillance is very perfect, but it is not reasonable to expect that we can concentrate an adequate force at a week's notice in any corner of the world, and a ship able to steam 350 miles a day for two months without coaling could shift her quarters pretty rapidly.

Now I think that were these vessels supplied with a moderate armament, and kept so with their present crews, they would be able to give a fair account of themselves to any of the scratch pack that at the first outbreak of a war would be most likely to attempt their capture and subsequent conversion, for if ever we are called upon to fight for our maritime supremacy, our men-of-war will be fully employed looking after the battle-ships of the enemy, and their fast armed merchantmen will for some time at least be able to harass our commerce seriously.

I will now proceed to mention the means that would to a certain extent obviate this evil, and in so doing I must not be understood as

prescribing a quack nostrum that will suit all cases, but my remarks apply, as I said before, to the vessel I command, and I know there are many such afloat to which they are equally suitable.

In doing so I shall bear in mind that merchant vessels are intended to carry freight and passengers, not to fight as long as they can run, that shipowners would have to look on any scheme such as this with a favourable eye to insure its success, but also to bear in mind with this latter proviso, that a possible moderation of a war premium might have a decided weight in turning the scale.

Another point is expense, and although last, it is not the least; but I think it may be found that by the expenditure of stores now idle in our arsenals and dockyards, a fair number of our long voyage steamers may be placed in a condition that could not be described as at the mercy of anyone. I speak more freely from the fact that I am left with free hands by the Company I now serve, they being willing to go to any reasonable trouble and expense to further any scheme of armament that might be decided on for their ships.

I take as my typical ship the "Kaikoura," of about 8,400 tons displacement at her load draft, 420 feet long, and 46 feet beam, built of steel, three steel decks, and bridge and poop superstructures, well subdivided by watertight bulkheads, and on the Admiralty list as complying with their requirements for an armed cruizer, boilers below the water-line, and engines are capable with little trouble of being protected with coal below the main deck to the extent of 12 feet in thickness on either side. The cylinder tops rise 6 feet above the level of the main deck, and these can also be protected easily by the same thickness of coal, or if bound from New Zealand, by closely dumped wool bales. This latter article has not been tried as a means of resisting shot that I am aware of, but as it assumes the hardness and solidity of wood or india-rubber under the enormous pressure to which it is subjected, I am under the impression that it would answer admirably, and yet not be liable to fire or blaze in such a manner as to defy an ordinary fire-hose. I mention wool bales because it might not be advisable to immerse a ship as deeply as full holds and a coal belt also would do.

This thickness of defensive material would, I take it, be beyond the power of a machine-gun to penetrate, except perhaps at very close quarters, and referring to the experiments of 1878, as per Gunnery Manual, page 258, I find that 12 feet of coal would afford protection from the fire of a 4½-ton gun, with a 24-lb. charge, at a range of 100 yards. I do not think that any merchant vessel could resist successfully anything larger.

If it were necessary, say if war were declared, to make further defensive preparations, steering gear might be arranged for various covered places, even to steer from under cover of the forecastle, as the wheel-house would be most assuredly riddled; boats could also be kept under cover of the bridge superstructure, and hoisted in or out with small derricks at either end. I do not enter further on these details, as being rather beyond the scope of this paper, my object being to put the ship in a condition to do her ordinary work, and yet

to be capable of easy transformation to a condition of tolerable defence.

I learned recently from the Officer who fitted out the steamship "Lusitania," that that vessel was armed with eight 64- and 40-prs., but this number would, I think, be too many by one-half for ordinary purposes. Four 40-lb. breech-loaders would be a fair armament to be constantly carried. These guns, mounted on wooden slides, with an arrangement of pivotting bolts, could be carried fore and aft abaft the gangways, clear of everything at sea and in harbour, and in no way interfere with the ordinary working of the ship. If it were needful to put the ship in a state of defence, it would be little trouble to mount one on the forecastle head, and another right aft under the poop superstructure, the remaining two could be fitted to traverse to either side, as they were required. I do not, however, think that the truck carriages on which they are at present mounted are at all suitable for merchant steamers, in fact very few decks could stand the handspike work necessary for training without soon showing signs of wear and tear.

I believe I am correct when I say there are numbers of these guns in store in various parts of the world. I know that I took out a quantity some three years ago to a naval station, and it is reasonable to suppose that there are similar weapons lying idle in England, which need not be deteriorated or spoiled by being placed on board the vessels now, on which they would be used in case of need, and with this advantage, that the crews of the vessel would get accustomed to them, even the men that were not in the Reserve. The same remarks would apply also to a supply of small-arms.

Of course I am aware that many other things would be required to constitute an efficient cruizer, but the arms I have mentioned would enable her to defend herself against a chance antagonist on the sudden outbreak of war. In the event of her being taken up by the Government, it would be a distinct advantage to find her to a certain extent already fit for her work, with magazines, &c., fitted, and, not least, with her failings discovered as a gun-carrying vessel. I have said nothing about machine-guns, they are expensive, are not bulky, and are susceptible of being easily fitted to a vessel in a hurry, and their comparatively delicate mechanism might require more care and attention than it would or might be always possible to give them in a vessel not carrying a large fighting crew.

Thus far I have spoken only of the equipment necessary to enable a merchant steamer of the first class to travel from port to port in unsettled times with any pretension to security. I wish that my knowledge of naval history would help me with some parallel case for a slow unarmoured man-of-war attacked by two powerful armed merchant steamers. No one knows better than a gunner that every shot that is fired does not hit. I have known a straight stem steamer start the entire side of a solid dock entrance with no damage to herself whatever, and unless her torpedo-boats helped the man-of-war she would be undoubtedly rammed and sunk. I touch very lightly on this subject, as there are so many things which have to be taken into

consideration. And again, the offensive is not so much my subject as to urge the adoption of measures which may mean in a great measure an important factor in considering the supplies of the country in war-time. It just occurs to me that Nelson's great want was frigates; had he lived now he could have had as many look-out ships for establishing communication as his heart could wish for.

With regard now to the manning of these vessels, no one knows better than a merchantman the immeasurable distance there is even between the smartest of mail steamers and a man-of-war. And although I have often heard it used as a fault or term of reproach, when applied to the master of a merchantman, "He tries to copy the Navy," I fail to see where the harm comes in. If a man chooses to make the Navy his standard of efficiency, he has chosen a very high one, and he may rest comfortably assured that he will be hopelessly beaten in his struggle to attain to it, but although beaten, he will not feel beaten, but will have the satisfaction of knowing that his efforts have been expended in the direction of bettering his service generally. Every man cannot have the good fortune to sail under the pennant, but nevertheless I think the greater proportion of the mercantile marine would feel both pleased and honoured if they thought they had a chance, however remote, of serving their Queen and country.

Now Jack has an old proverb which says, "Different ships, different long splices," and that applies very closely to the mercantile marine of this or any other country. If you want them to make a splice, metaphorically, you must give them a splice to make that they are accustomed to, and let them do it in the manner that suits them best, or in other words it may be put that Merchant Jack sings out on a rope, when he is pulling, because he says it helps him, and Navy Jack does not, because there are generally men enough for a stamp and go, and he is not permitted to make a noise. I say this, because if mail steamers were armed to-morrow, it would not be possible to carry out the routine in the manner Naval Officers have always seen it done, but my experience is that the crew of a mail steamer are susceptible of a very large amount of discipline. Treated with a firm but kind hand, fed well, and worked judiciously, I really believe that, strange as it may appear, Jack does not dislike his ship, and a moderate amount of coercion.

This conviction has been forced upon me latterly, for as by the present Merchant Shipping Act there is hardly such an offence as desertion, as the sailor can give two days' notice and leave his ship, I have found my crew remain almost intact, in spite of the very much higher wages they could have got abroad, and I know that a crew will remain a long time in a ship if they are permitted to do so.

In all my remarks concerning mail steamers, I am assuming that they are commanded by Officers of the Royal Naval Reserve, and that they are in possession of the warrant authorizing them to wear the blue ensign of Her Majesty's Fleet. Few Officers in Her Majesty's Fleet know the amount of self-denial that is necessary on the part of a Reserve Officer to fulfil his drill engagements. For the most part in constant employment, his only chance when he gets a fortnight's

leave or so, is to take lodgings fairly close to some drill ship, and devote the hours of drill to the endeavour to pick up as much gunnery and useful knowledge as he can persuade people to teach him; that is, of course, if his heart is in his work. The Sub-Lieutenants who do no drill are, I am glad to see, growing into a small minority on the active list, but every leave that I have had since joining the Reserve has been taken up by drill, so that I quite recognize the difficulty.

There is this to be said, that when an Officer has done three months' drill, say in the "President," he should have a fair practical knowledge of gunnery, and would not learn much more in that ship, unless he acquired a greater facility in handling men at battalion drill, which for an Officer in charge of a merchant steamer is quite unnecessary, and nearly useless; on the other hand, *if* Officers, on attaining a certain standard of efficiency, were permitted to take a short course of gunnery on board the "Excellent," it would be a great boon to the younger Officers especially, who, by making an effort, might possibly be able to avail themselves of the chance. It would do a great deal of good in many ways, for my experience is that even the short training they undergo now makes better men of them. I say nothing of the advantage it would be to the merchant service generally if Sub-Lieutenants, newly made, were permitted to go for a cruize with the Channel Squadron. It was quite a step in the right direction when some Officers were allowed to sail in the Evolutionary Squadron last year. It was only by a correspondence with the Admiral Superintendent of Naval Reserves some years ago that I succeeded in getting the Gunnery Manual supplied to Officers who had passed their test examination. It appeared necessary to point out that some Officers wished perhaps to know a little more of gunnery than was to be acquired by mere drill, and this privilege is capable of extension to many books not to be obtained by purchase, but which would be studied attentively by men to whom possibly the knowledge might prove some day of the utmost value. There is one way by which the number of Officers in the Reserve might be largely increased, if it were ever required to do so, and I am speaking now more particularly of Engineer Officers, for if we should ever again engage in a big naval war, there would not be too many combatant Officers left at the finish.

If it were once understood that on being called out on a national emergency it would be optional on their part to retain their position in the Navy at the close of the war, the matter would be settled, but it would not give a man much heart to know that he had lost his berth at the beginning of a war, and at the end was to be cast adrift to begin again, very possibly at the bottom of a strange service.

I have often been asked what advantage it is to hold a commission in the Reserve, and I think that all I have been able to say up to the present time is, "Why, your ship can wear a blue ensign under certain conditions;" but really I look to it as a means to an end, which is summed up in a few words. *I do not see there is any reason why an Officer commanding a mail steamer should not be able to sail his ship in the piping times of peace, and fight her as well as another man if*

it came to war. It has been advanced on more than one occasion that were merchant vessels armed and then captured by an enemy, the crew would be liable to treatment as though they were privateers. I cannot see that that argument holds in this case. A steamer is authorized by Admiralty warrant to wear "the blue ensign of Her Majesty's fleet," so runs the wording of the warrant. It follows therefore that a vessel carrying by right the flag of Her Majesty's fleet could not possibly be a privateer. It might as well be said that the endeavour to ram an enemy attempting his capture, by an unarmed ship, constituted him a privateer.

I am aware that there would be some difficulty at first in getting enough Officers together in any one ship. I am particularly fortunate, as I happen to number two well-trained Sub-Lieutenants amongst mine, but that would be a matter of easy adjustment; for instance, it might be arranged that selected Officers from a ship wearing the blue ensign should be permitted to receive instruction, without pay, on board a drill ship with a view to qualifying for a commission. This, with the drill they would get on board their own ships would meet the requirements of the case, and be of vast service to the merchant service generally: furthermore the principle of selection of Officers will have to be adopted in future if the Reserve is to be efficiently officered; I say this because the sole promotion from midshipmen shuts out numbers of the best men.

The men of the Royal Naval Reserve are, I have no hesitation in saying, the pick of the mercantile marine, not perhaps the prime seamen of thirty years ago—steam has spoiled all that—neither are they as good as some well-trained men-of-war's men, who have been taught and brought up in a training ship from the time they were first caught, if it comes to a complicated matter of knotting and splicing; but for the ordinary duties of a seamen they do well, and have this advantage, that they are accustomed to do a lot of work with very few men, and to make the best of materials at hand.

The training also that the men have gone through has exercised a marked influence for good throughout them all. Jack is quite clever enough to see that a system of working saves trouble, and he can also appreciate the advantages of a firm and consistent discipline, and last, and not least, they are so well and fairly treated on board the drill ships, that the Reserve grows more popular with them every day.

These men have to drill four weeks every year, and as I confine my remarks to the vessel I command, I must point out that she is only in England three times a year for about a fortnight at a time, sometimes less, so that to retain the same crew under existing conditions is rather difficult, but even with these adverse circumstances I have frequently found the gaps filled up by men who have left on a preceding voyage. Similar cases might be met by a certain amount of liberty being allowed to *trained* men who had served in a vessel carrying guns upon the certificate of the Officer commanding, the drill they would undergo on board her might count for say a week of their shore drill in twelve months, and one great advantage would be that the men would be kept together, and that if the ship were

required for war purposes abroad there would be the nucleus of a crew in her. I have been informed that Naval Reserve men were not plentiful in Australia last year when war seemed imminent.

In the event of arms being supplied to a steamer it would of course be necessary to have one man whose sole duty it would be to attend to them, in fact to act as gunner; and there is this difficulty, that the British shipowner as a rule expects each man on board to take his place as a part of the money-earning machine, so that it is problematical whether he would see his way clear to paying the expenses of a gunner.

The suitable man for the berth would be a gunner's mate that had been a year or two in a drill ship. If he could be put on board by the naval authorities so much the better, the plan would have many advantages, otherwise if he were taken at the expiration of his time in the Navy, he would have to sign articles as boatswain's mate or quartermaster, the latter for preference; there would be no trouble in getting good men, as their pay in that capacity in addition to their pension would be eagerly sought for. I must again repeat that I could not enter upon this matter of expense were it not that I have the sanction of the Directors of the Company I serve. I am aware that this might not be universal, but I think I could mention others who would look upon the scheme favourably, but I have a strong feeling in favour of a gunner's mate being put on board by the naval authorities, to be attached to the Warrant Officers' mess.

I have endeavoured to deal with this matter in a strictly practical manner, without turning to outside issues, and having due regard to the numberless difficulties that always crop up at the beginning of any new scheme, I have taken it from the standpoint of the man who would have to carry the thing into practice, that is, the master of a mail steamer. The more I look at it in all its bearings, the more convinced I feel that the arming of fast merchantmen for long voyages will sooner or later become an absolute necessity. No one knows the weakness of a merchant steamer for war purposes better than myself, with its numberless steam pipes and stearing gear exposed: but the knights of the Middle Ages went to battle in armour, and is it not possible that the ponderous ironclad and 100-ton gun will disappear in a similar manner to these steel-clad gentlemen, and that unarmoured ships and lighter guns will once more decide who is to have the supremacy of the seas?

In the meantime we have to grasp the matter as it stands at present, and it was only the other day that I heard Admiral Tryon tell the people of New Zealand that in spite of their recently made fortifications, their power for defence did not extend beyond the range of their guns, and that their commerce was in peril from any cruizer, unless their batteries were supplemented by a force afloat. Now the chances of any armoured vessel belonging to an enemy of Greater Britain getting to New Zealand are very small, and as there are always two of the vessels of the type I have described in New Zealand, they, if armed even in the manner I suggest, would be no mean or inconsiderable enemies for a stray unarmoured cruizer to

reckon with. Another thing also, they being five weeks in New Zealand going from one end of the islands to the other, would have ample opportunity of exercising their men at target practice, and the handling of guns at sea, a very different matter from doing so in a perfectly stationary drill ship, in fact no great number of the reserve men ever get the chance to see their sights "roll on;" there are no coast passengers carried, the crew do nothing with cargo, and there would be every chance of getting the ships into a fair state of efficiency.

I am aware that I have narrowed the limits of this paper very much, and that it is capable of far greater expansion than I have given it. I have done so purposely, as I do not wish to trespass too long on your good nature, but as we are the largest immeasurably of all maritime Powers, consequently it devolves upon us to pay a heavier insurance on our property, and to adopt measures that would be uncalled for in a smaller nation. Everything tells us, that as we are the largest, so should we be incomparably the strongest at sea; leaving aside the vexed question of ironclads our merchant steamers have *no* rivals under any conditions. I commenced with an excuse for venturing on the subject at all. As I have gone on the apparent necessity for an excuse has disappeared, and in its place remains a feeling of regret for the inefficient and imperfect manner in which the subject has been handled. I can only hope that these few words of mine may have the effect of rousing into action some powerful pen that may do the subject justice, and cause it to be ascertained, whether numbers of our finest ships are to be placed, say but for a month, at the mercy of every so-called "Alabama." Even supposing that one or two armed merchantmen were sunk, they would have inflicted some proportionate amount of damage on their conqueror, and to disable even one hostile ship would mean to us far more than the loss, say, of six of our own. Whether my remarks will be favourably received I know not, but I am not aware that the matter has been brought before this Institution previously from a master mariner's point of view, and in so doing I have endeavoured to pay a small instalment of the debt that every man is said to owe to his profession.

The CHAIRMAN: Lieutenant Crutchley has dwelt upon many points of very great interest with respect to the arming of merchant ships, and also with respect to their crews, and the manner in which they are to be officered in time of war. I trust that several of the Officers present will take part in the discussion.

Admiral Sir ERASMUS OMMANNEY: Lieutenant Crutchley has dealt with this subject from a really seamanlike point of view, and on the whole I think that his suggestions are very good, and worthy of the best consideration. I should like to ask, with regard to the manning question, how far Lieutenant Crutchley's Directors would be prepared from a commercial point of view to increase the crews of their ships? I think the suggestion to have a gunner's mate on board the ship, provided that you do carry heavy guns, would be a very admirable one. I should like to know whether your ship is one of those in which the structure meets the requirements of the Admiralty for offensive and defensive purposes, and whether, in your opinion, the ship which you command is strong enough to be classed as an armed passenger ship?

Admiral NOWELL SALMON: I only returned to England this forenoon, and on my arrival I found a telegram asking me to be present on this occasion. I am very happy to do so, having made Captain Crutchley's acquaintance at the Cape of Good Hope some time ago, when he was in command of one of the mail steamers. I may say Captain Crutchley was one of those members of the Naval Reserve who met my advances towards them in a proper spirit. There were very few instances, I am happy to say, in which they were not so met. I think that such *rapprochement*, if I may be permitted to use the word, is very necessary to both services, both to the Royal Navy and to the Royal Naval Reserve. Unfortunately, as I say, I did not return to England till this forenoon, and I had not read this paper before coming here. When I first took it up I was under the impression that it was on the subject of arming merchant ships to do the duty of men-of-war. I find, however, it is for the purpose of arming merchant ships to take their own part as merchant ships. I think very likely the question will arise, if a merchant ship takes upon herself to use weapons against an enemy's ship, whether she would be considered warranted in doing so. I think a ship would require some warrant from the Government to admit of her using weapons even in her own defence. That seems to me to be a point of difficulty. Another point, with respect to which Captain Crutchley perhaps has not had so much experience as I have had, is the fitting out of vessels, which he speaks of as being necessary for his purpose. I had occasion to fit out a vessel at the Cape of Good Hope, and I quite admit the use that that vessel would have been to the service, had she been required as a cruizer. When I first undertook to fit her I was under the impression that, in addition to all the fittings necessary to make her an armed cruizer, she would carry sufficient coal to be of use to the squadron in general, in fact, to become an armed collier, but by the time I had got all the weights necessary to make her an armed cruizer I found that there was not much room—I should say tonnage—left for carrying coal. I think that Captain Crutchley would find merchants indisposed to give up the weight necessary to arm them under ordinary circumstances. I do not see that there is any reason why an Officer commanding a mail steamer should not be able to sail his ship in the piping times of peace, and fight his ship as well as another man if it came to war. I believe there are a great number of our Officers who are commanding steamers, who would be perfectly competent to fight their ships in case of war if they had the necessary authority to do so. At the same time I believe the first paragraph of the paper we have heard read cuts the knot of the whole question, and that is that you had better trust to your heels and run away, and then I do not think there is any man-of-war afloat that would ever catch you in a long stern chase. I speak with a considerable amount of certainty of our own ships, and I doubt if there is any man-of-war afloat which, in the case of one of our mail steamers having, as Captain Crutchley describes, a start of ten miles, which would be increased by the time the man-of-war had got up steam to full speed, say to 14, would be able to catch that merchant ship. Men-of-war cannot get at their coal with sufficient readiness to enable them to keep up their high speed. I do not think that a merchantman such as Captain Crutchley commanded when I had the pleasure of making his acquaintance, namely, the "Mexican," which would go and go on at 14 knots, would have anything to fear from any man-of-war afloat. There is another point on which I must venture to express some little doubt, that is as to the crew accepting what we may call "war risks" in a ship not fitted out to do man-of-war's duty, but armed to protect herself. Even in the case of a ship fitted out to do man-of-war's duty I found great difficulty in getting men to accept war risks at any price. The Naval Reserve men of course had to come, that there was no doubt about, but there was great difficulty in getting men to accept the risks under any other circumstances. I am sorry to say some little difficulty has since arisen in some cases, and there is no doubt great hardship was inflicted upon certain members of the Naval Reserve Force which they had not expected, or at any rate had not realized when they joined it, and not only hardships, but considerable loss, both directly and indirectly. I think there are points of some importance with regard to expecting the crew of a merchantman to fight their ship. I beg to compliment Captain Crutchley on his very practical paper, and I shall be very glad to confer with him at any time on the subject, and to give him the

benefit of my experience, and to hear from him exactly how far his Directors are prepared to go; but until it is put on a plain footing I do not think we can ever arive at any satisfactory results. I thank him very much for bringing this subject forward, as it is one of very great importance, and I also compliment him upon the ability with which he has brought it forward.

Admiral BOYS: I trust I may be allowed to congratulate this Institution upon getting a paper on this subject read here by an Officer of such practical experience as Captain Crutchley; and I may also congratulate the Mercantile Marine on possessing amongst its members an individual who is willing to take the trouble to collect and so ably put before us Naval Officers all the information it contains. I think the gist of the paper is comprehended in these few words:—"I do not see there is any reason why an Officer commanding a mail steamer should not be able to sail his ship in the piping times of peace, and fight her as well as another man if it came to war." Nor do I in the least, but my difficulty in this case is that, if a merchant steamer is to be a fighting ship and a merchant ship at the same time, she must be under two masters; there must be a dual control; because for her fighting arrangements she must be under the Government, under the Admiralty, and for her trading and cargo arrangements she must be under the control of her owners. That is a difficulty which might be overcome; but it is a thing to be seriously thought of. I was only last week reading a book lately published by a very eminent man, Mr. Froude, entitled, "Oceana," and we are there told that, when he was taking a passage from Australia to New Zealand (I think it was) in a large steam vessel, the captain said to him, "I make it a point never to take any Englishmen for my sailors, if I can help it. I much prefer Danes and Swedes, and all my servants and stokers are Chinamen." I should like to ask the lecturer if, from his experience, that is the case generally amongst the large merchant ships working in those waters, as it has a very important bearing on the subject before us. With regard to the war risks in connection with crews, that Admiral Salmon has alluded to, I think there is probably some misunderstanding, because, if any English merchant ship were attacked by an enemy's vessel, and there was the slightest chance of escape by a successful resistance, I believe the crew would defend her to the last, not only as Englishmen, but for the simple reason that it would be far preferable for them to continue their voyage in her than to become prisoners to the enemy, with a very uncertain future before them. For this reason only I think they would fight.

Lieutenant W. BADEN-POWELL: If I may say a word or two upon this subject, I should like to commence by saying that I must have been utterly misled by this paper in looking over the copy which I obtained from the Institution, for I read it as a question of calling out merchant ships in time of war, and arming them for offensive purposes. Now it seems the lecturer means that they are purely and simply to be armed for their own defence. There you come at once to the difficulty of the whole question of arming merchant steamers or any vessels except men-of-war, that you put yourself under the Declaration of Paris; and, unless you are under the orders of the Admiral of the station, and are part of the Navy of the State, you are a privateer, and a privateer, under the Declaration of Paris, is a pirate. Therefore you have the further difficulty that you will get no men to serve, or as soon as men, whether Naval Reserve men, or anybody else, find that the ship is not actually *bonâ fide* a man-of-war, they will probably leave, and I don't blame them. Admiral Salmon, with regard to Naval Reserve men, said just now that he found a difficulty in getting men to join a ship with war risks, and we found Naval Reserve men objected, but they had to come.

Admiral SALMON: I did not say that. I said Naval Reserve men of course did come; they had to.

Lieutenant BADEN-POWELL: I thought there might be some little slip of the tongue, because, as far as I am aware, Naval Reserve men have not yet been called out.

Admiral SALMON: The Naval Reserve was called out at the Cape, owing to the telegraphic communication having broken down.

Lieutenant CRUTCHLEY: Would you mind stating with what result they were called out?

Lieutenant BADEN-POWELL: They could not be called out without the Queen's Proclamation.

Admiral SALMON: They were called out by order.

Lieutenant BADEN-POWELL: I am afraid the order was wrong. The Act of Parliament only entitles the Naval Reserve to be called out by Queen's Proclamation in time of danger to the State.

Admiral SALMON: If you think it necessary, I will explain the circumstances.

Lieutenant BADEN-POWELL: Admiral Salmon quite rightly said, to my way of thinking, that the blue ensign, though called the blue ensign of Her Majesty's Fleet, would certainly not cover a fighting ship in war-time. There would have to be a warrant from the Admiralty, and Officers commissioned for that and for no other purpose. The whole vessel would have to be put under the State as a State ship, and, if the rules of the Institution would allow me, I have brought with me a pamphlet by a very eminent lawyer on the question of international law, from which we find that this very question arose in the Franco-Prussian War. He says, in the Franco-Prussian War the Prussian Government called upon the country to supply men and ships for the purpose of defending the State. France at once objected; England was asked to take the matter up, and England decided that in the Franco-Prussian case they were entitled to do what they were doing, because the merchant shipowner put his ship unreservedly in the hands of the State, and she became a man-of-war of the State, a part of the Navy of the State, and the men signed the articles of war, and wore the uniform and badges of the Imperial Navy according to their rank. That is the only point upon which the Law Officers of the Crown said that they were entitled to send those ships to sea without their running the risk of being captured as pirates; and it would be very hard lines for the men of our mercantile marine to be told that they would be perfectly safe under the blue ensign to defend themselves in time of war, and to find themselves left in such a hole that their only chance of having anything to say in the matter would be to write a letter half-an-hour or so before they were run up to the funnel, for I suppose there will be no yard-arms in future men-of-war.[1] These

[1] No occasion for the interpretation of the first article of the Declaration of Paris of 1856 arose in its application to a war, in which both the belligerent parties were signatories of that Declaration, before the Franco-German War of 1870, when the Prussian Government issued a Decree (24th July, 1870) relating to the Constitution of a Volunteer Naval Force. Under that Decree the King of Prussia invited all German seamen and shipowners to place themselves and their forces and ships suitable thereto at the service of the Fatherland. The Officers and crews were to be enrolled by the owners of the ships and were to enter into the Federal Navy for the continuance of the war, and to wear its uniform and badge of rank, to acknowledge its competence, and to take an oath to the Articles of War. The ships were to sail under the Federal flag and to be armed and fitted out for the service allotted to them by the Federal Royal Navy. The ships destroyed in the service of their country were to be paid for to their owners at a price taxed by a Naval Commission, and a sum was to be paid by the State as a deposit, when the ships were placed at the service of the State, which, at the end of the war, when the ships were restored to the owners, was to be reckoned as hire. The French Government, regarding the institution by Prussia of a volunteer naval force as the revival of privateering under a disguised form, lost no time in calling the attention of the British Government to the Royal Prussian Decree, as instituting an auxiliary marine contrary to Prussia's engagements under the Declaration of 1856. Earl Granville, on behalf of the British Government, referred the matter to the Law Officers of the Crown, and in accordance with their opinion returned for answer "that there was a substantial difference between the proposed naval volunteer force sanctioned by the Prussian Government and the system of privateering which, under the designation of "La Course," the Declaration of Paris was intended to suppress, inasmuch as the vessels referred to in the Royal Prussian Decree would be for all intents and purposes in the service of the Prussian Government, and the crews would be under the same discipline as the crews on board vessels belonging permanently to the Federal Navy." Upon these considerations the British Govern-

things are matters that should be settled and known, and seamen who take service in the Naval Reserve ought to know whether they are running risks or not; because it is all very well to say the Declaration of Paris won't stand in war, the fact is it does stand; in the Franco-Prussian War it was appealed to, and it was only owing to their throwing the whole of the Volunteer Service entirely into the hands of the Government that it escaped being a piratical institution. I have heard no such idea broached in this lecture. It seems to me simply that they ask leave of the State to arm their ships, so that they may fight if they are attacked at sea. I think Captain Crutchley would bear me out when I say that a merchant ship, such as our modern mail-steamer, one of those long ghosts of misery I was going to call them, for they very nearly are, is about the most unhandy thing that you can try to fight on sea. It is worse than any of your citadel-ships. It has only got a pair of heels to run away with, and if once it came in close quarters with one of the smallest corvettes it would be knocked into a cocked hat in a few minutes. Its steampipes are all exposed, its screw-propeller is far too near the surface of the water; the slightest ground-swell would pitch it out of the water, and a well-aimed shot would probably either take the rudder or the propeller. We have also to consider how this ship is going to perform the two duties of being an armed cruizer and carrying passengers and cargo. She cannot do it. She must for her armed cruizer purposes be under the order of the Admiralty, and the Admiralty, if it wants her, will stop her, and her perishable cargo of frozen meat, which the country would be most wanting in case of war, would have either to be eaten by the Fleet or to perish. It seems to me that the whole subject is much too large to be dealt with in a casual kind of a way between one set of shipowners and, I was going to say a private Admiralty, a department of the State. It is a national question which ought to be discussed to-morrow, and other nations ought to be interviewed on the subject. I should like to say that, the sooner we drop the Declaration of Paris, the better. The Declaration of Paris did away with privateering; privateering was our strong arm for hurting other people, and I very much doubt whether any other country could combine to hurt us to the extent to which we could combine with our merchantmen to hurt them. Then we should be able to arm our merchant ships without question and do as we liked, and our merchantmen could look after themselves to a certain extent. There is only one other point which I should like to touch upon, that is, that Admiral Salmon said he came to the conclusion that when he had armed the merchant ships with the guns, and the weights necessary for them, there was very little room left for carrying coal. I do not know what the construction of that ship would be, but my experience of merchant ships is that many of them carry some 3,000 tons of cargo, and I should fancy the armament would certainly only come up to 30 or

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ment could not object to the Decree of the German Government as infringing the Declaration of Paris. ("British and Foreign State Papers," LXI, p. 692. Perels. "Manuel de Droit Maritime International," p. 195. Paris, 1884.) There is not an unanimity of opinion amongst text writers on International Law on the subject of this Prussian Auxiliary Marine, as to whether its institution was in conflict with the Declaration of Paris or not. M. Charles Calvo, Ancien Ministre, considers that vessels equipped in accordance with the Prussian Decree may be regarded as privateers of an aggravated character, seeing that the owners are not required to give security for their good conduct ("Le Droit International." Troisième Edition. Tome Troisième, p. 303. Paris, 1880); and Mr. W. E. Hall, in his recent work on International Law, p. 455 ("International Law." Oxford, at the Clarendon Press. 1880), observes that "unless a volunteer navy could be brought into closer connection with the State than seems to have been the case in the Prussian project, it would be difficult to show that its establishment did not constitute an evasion of the Declaration of Paris." But neither of these eminent publicists seem to have given sufficient weight to the provisions of the Prussian Decree, under which the Officers and crew were required to enter into the Federal Navy for the continuance of the war, were to wear its uniform, and to take an oath to the Articles of War. Further, the vessels were to be fitted out by the State, and were to sail under the public flag of the State.

40 tons with ammunition, so that, even taking it at 100 tons, we should have something like 2,000 to 3,000 tons left for carrying coal. That again shows where the Navy would be; a wily Admiral would say, "Come along with me with your armed merchant ship, and have her full of coal," for by that means he would have a collier always alongside of him. Then, as to the crew, where are you going to get all these Naval Reserve men from to man these merchant steamers? It is not so very popular a Service already. There was a very long speech made the other night in the House of Commons on the Navy Estimates, in which it was said that Naval Reserve men were very scarce, and that out of these large mail-steamers there were very few indeed that had Naval Reserve men on board. I think that is perfectly true. Owners, as a rule, do not like to carry Naval Reserve men, because they are afraid that on a declaration of war they would have their best men whipped out of the ships at the very time when they could not get foreigners to serve in their place, because foreigners would not dare to serve under the English flag in war-time. So that it seems to me the questions opened up by this excellent paper are larger than were anticipated when the lecturer commenced. They are national questions, and of the most important nature that you can imagine. I look with distrust upon the whole subject of depending upon the merchant navy for fighting purposes in war-time. I think it is only a plant on the British public, it is only trying to keep the British public from clamouring for those handy fast corvettes of the "Esmeralda" type that we ought to have to keep our commerce in its proper place; and, if the merchant shipowner pays his taxes for a Navy to look after his commerce, he ought to have it, and ought not to be expected to keep his own policeman to protect his house against the robber.

Admiral SALMON: I may, perhaps, explain that at the time of the Russian War scare the telegraph wire was interrupted between England and the Cape. I had occasional communications by steamer, and by one of those steamers I received orders that, if I got no further orders within ten days, I was to call out the Naval Reserve, because by that time the Queen's Proclamation would be out. The cable remained interrupted, ten days passed, and I called out the Naval Reserve, and did the best I could with it. I think a little mistake must have been made by Mr. Baden-Powell in saying that I said that there would be no *room* left for coal; what I said was that there would be no *tonnage*; I think that, if he calculates up Captain Crutchley's 12 feet of coal round his engines and boilers, and the vulnerable part of the ship, he will find that it comes to a considerable tonnage; we have plenty of room, but we have not got tonnage. I speak from experience because I have tried it.

Admiral FREMANTLE: We seem to have digressed a little from the paper itself, and, as it will be in the memory of a great many of us that we had, I think, three interesting discussions on the question of the Treaty of Paris, than which no more interesting question can be discussed, whether in this theatre or elsewhere, I think we should be well advised in not going further into that subject. I must say I was a little surprised at the contention that an armed merchant ship was contrary to international law. I certainly did understand that, by the Treaty of Paris, privateering was abolished, but are people not allowed to fire a shot in self-defence? I think such a suggestion will be a new light to some of the people here present. Lieutenant Baden-Powell has, I am aware, given a great deal of attention to this subject, and perhaps he may be right, but certainly there were a great many cases in the old war of armed merchant ships defending themselves, and with success, against ships of the enemy. Those vessels were not privateers in the sense in which a privateer is generally understood; they certainly bore no letters of marque. I would simply mention the case of the "Warren Hastings." She was an East Indiaman, equipped to a great extent for war very much in the same way that our lecturer proposes, and she fought an action, though not a successful one, against a French frigate, the "Piémontaise," but it was an action on very nearly even terms. The French frigate was very well commanded, and at length succeeded in taking her; but that was not looked upon as any question of privateering. So that I venture to think there may be a distinction between a merchant ship armed for self-defence and an armed merchant ship which carries letters of marque and is intended to prey upon an enemy's commerce. The essence of the whole question now before us is that of speed. Unless it was the fact that our merchant ships are

vessels of very great speed, a speed which I am afraid we can scarcely equal in the Navy, the question of their cruizing alone, and not in convoy, would scarcely be taken up. Lieutenant Crutchley says, "There are very few men-of-war afloat that in war-time could afford the time and coal expenditure necessary to catch a 14-knot merchant steamer." I am afraid most naval Officers here will entirely agree with him on that point. I took the trouble to look through the Navy List somewhat hurriedly yesterday, and I think I am not very far wrong when I say that amongst the men-of-war, those actually afloat, counting those that are fitting, but not those still on the stocks, I made out that there were only about thirty or forty which were capable of going at 14 knot speed, even for a matter of twenty-four hours. I included in that category vessels such as the "Dreadnought" and "Thunderer," whose speed is about 14 knots, and they may probably keep it up for twenty-four hours, but, as for keeping it up for a week, they could not do it. I do not believe there are a dozen that could keep it up for a week.[1] Under these circumstances, it adds great importance to this question of whether a merchant vessel should be armed or not. If we are not to have armed merchant vessels, and if international law does not allow them to be armed, though, as I say, that is a new light to me, I think there is no question that we should be bound at once to build a large number of "Esmeraldas." On that point I agree with Lieutenant Baden-Powell. There is a question as to the weights of the armament. I have an old lecture here of Captain Long's, a very able lecture, treating on the same subject from an entirely different point of view. His calculation was for ten guns, and he gives the total weight for guns and ammunition as 81 tons. He alludes very fully to the question of the merchant steamer, and puts the largest of such vessels as 450 feet in length. But that is not the extreme length of the steamers we have at the present day. We know very well that some of our new vessels, the "Etruria" and the "Umbria," are 550 feet in length. The reason I allude to that is that I should have very much liked the lecturer to have gone into the question a little more fully in some respects, such as whether in these very large and long vessels, like the unfortunate "Oregon," which went to the bottom the other day, where they have the large compartments which we know Sir Thomas Symonds speaks of as "large sinking compartments," and what effect one of those large compartments being filled would have upon the immersion of the ship. That is a very large question, because it seems to me that none of these merchant ships are at all capable of anything like efficient defence unless their compartments are of that size that one or even two might be filled without the ship going to the bottom. That can never be done till we have double-screws in our merchant ships, and there again we touch upon a question of the highest importance. With double-screws you have two engine-rooms, the ship is divided fore-and-aft, and consequently the "sinking compartments" are only one-half the size. The question of the area of the rudder, as Captain Long points out in his lecture, is of great importance. In the merchant-ship that he refers to there, he gives the rudder area as 125 feet, that of the "Minotaur" being 198 feet, and that of the "Agamemnon" 143 feet. The standard which he takes is the area of the midship section divided by the area of the rudder. He has taken one of his long merchant ships, "Atlantic Mail Steamer" he calls it, and he puts her coefficient as 92. I was alongside him at Malta in December, 1884, when he was trying his circles in the "Agamemnon," and our attention was naturally directed to this subject. The coefficient for the "Agamemnon" was 46, or exactly half. People are perfectly aware that the "Agamemnon" did not steer well, but the fact is she was like a dish, she turned a great deal too much, and her failure to steer was certainly not due to want of rudder surface. The "Dreadnought's" coefficient we found to be 51. From 46 or 51 to 92 is a very large step, and, unless merchant ships can have larger rudder surface in proportion to their size, and can have double-screws so as to enable them to steer by the screws in case of injury to the rudder or steering gear, I must say I do not see myself how any merchant ship can make any effective

[1] Having looked more closely into this subject since, I much doubt if we have a single vessel belonging to the Navy afloat capable of steaming 14 knots for one week. Possibly the "Iris" and "Mercury" could, but those who know these ships best are not sanguine on the subject.—E. R. F.

defence against even the smallest of corvettes. I wish specially to thank the lecturer for the practical way in which he has treated this subject. The question of whether merchant captains should be allowed to command their own ships in case of war, if fitted as cruizers, would depend on their being capable of commanding them efficiently if commissioned as men-of-war. I think there is very little doubt, if these Officers will take the trouble to pass through the present course, and if, in addition to that, they were able to go to the "Excellent" and improve themselves still further, there would be no reason why they should not be allowed to command their own vessels—at least it seems to me it might be so. I am one of those who do think it is perfectly impossible to have a reserve of Naval Officers for service in the Navy in case of war, and under those circumstances we certainly ought to turn to our Royal Naval Reserve Officers. This, indeed, sounds like a truism, and I am extremely glad that during the past year some of those Naval Reserve Officers did go out with the fleet, and, as I understand, made a very good impression, and I hope it will be a course which will be followed more fully in the future.

Sir NATHANIEL BARNABY: I have listened with a great deal of interest to the very remarkable paper which has been read. It gave me very great pleasure to find an Officer of the Royal Naval Reserve venturing into the midst of the Naval Officers here and reading a paper of that kind, and it has given me more pleasure to find how well it has been received. It is a very difficult subject. Some of the points mentioned by Mr. Baden-Powell are no doubt accurate, but with some I do not at all agree. One thing may be taken as true, namely, that in time of war any merchant ship could, by having the Queen's commission given to her, be authorized to defend herself; that is all we require. But the question as to what she could do may, I think, be best looked at in this way. Supposing that off one of the ports, where large numbers of sailing ships and slow steamships are coming and going at the outbreak of the war, there is one of these merchant ships, which some Officers think so weak and so incapable of doing anything, belonging to our enemy. Suppose she has only one screw—well, it is a poor look-out when a ship has only one screw! —she is very narrow—she would be a great deal better ship if she were wider—still there she is, she is fast, she has got a lot of coal, she has fighting men on board, and she has guns. What, I should like to ask, is going to happen to the sailing ships and the slow steamships; what can they do? You may say that, not being a regular ship of war, the enemy's ship ought not to be able to do anything to them. It is perfectly certain that she will, and the question we have to consider is, can we by any extension conceivable of the regular forces of the Navy make shipowners feel secure, when war is declared, that they would not have their ships snapped up? I say that you cannot: that you may spend as much money as you please, and you never will make your shipowner comfortable if he is dependent for the defence of his slow ships all over the world on what you can do for his defence with your regular ships of war alone. Consider what would be the result if the enemy with whom you are contending got hold of some of your despised and fast cruizers, and armed them and sent them out against your commerce. It is not the question as to whether the "Oregon," if she had been met by one of the regular ships of war, say the "Inconstant," or some vessel of that kind, would not have been in a very bad case—that is a debateable point—I should be very glad to debate it. My opinions might not agree with some of yours. I think the "Oregon" was a very good ship. The fact that she floated for 8½ hours is something very much in favour of a ship of that kind. And I can tell you something else about the "Oregon;" she might have had *any two* of her compartments filled with water, and she would not have sunk, had her doors been shut. I do not wish to say anything about the ship which is commanded by the gallant Officer who has been speaking to us. She is on the Admiralty list, but she is not a ship to compare with the "Oregon." But the "Kaikoura," if she were commanded by our friend and were sent to attack an enemy's commerce, you would find, I believe, would make a very good account indeed of any ship that she might come across. I have been talking to Naval Officers for years about this matter, and I am pretty well tired of it. The Naval Officer believes very much in the Broad Arrow; but after all he has to consider the wide question I put just now: can the merchant shipping of this country be defended by any expen-

diture conceivable upon the *regular* Navy? I say it cannot. If you think you can show that it can, then I most sincerely wish you would join in getting the ships. If you think it cannot, then consider what would be the state of things without good merchant auxiliaries when war broke out, looking at our vast merchant marine with half its tonnage sailing, and a vast proportion of its steam tonnage very slow. My own belief is that, until we have the question considered deliberately, thoroughly, and exhaustively in the light of the facts which were put before Lord Carnarvon's Royal Commission, we never shall get a settlement of the question. As to giving up the Declaration of Paris, I should fight against that with all my soul. I believe it would be entirely wrong to go back upon that, and that we are in a far better position with it if we will only use our advantages rightly. The question really is, I think, not what the owners of the "Kaikoura" will do for the Government, as one of the speakers has asked, but what the Government will do for the owners of the "Kaikoura" and of such ships.

Captain CURTIS: We have been asked by the lecturer for a precedent with regard to merchant ships defending themselves against an enemy. In the Governor's room of Christ's Hospital I have seen a picture of Commodore Dance, in the H.C. ship "Earl Camden," with 15 other Indiamen and 14 coasting ships under convoy, beating off a French squadron of men-of-war, consisting of the "Marengo," 84 guns, bearing the flag of Rear-Admiral Linois, and two 44-gun frigates, a 28-gun corvette, and a Balarian 18-gun brig, on the 15th February, 1804, off Pulo Aor, in the China Seas.[1] I freely concur with previous speakers in thanking Lieutenant Crutchley for this lecture, and it no doubt requires some amount of boldness to come before an audience of Naval Officers with a paper of this sort, and subject it to their criticism. With respect to guns, Lieutenant Crutchley doubted the use of having machine-guns. Now, if a torpedo-boat is coming up under your stern or quarter, that boat will be some time under fire, and I have heard Admiral Lethbridge say in this theatre that truck guns are of no use on board these ships. I have seen truck guns in a ship off Cape Horn in a swell, when the decks were wet, take charge when the falls were bracketed, swaying fore and aft, and the men jumping over and mounting the guns to prevent their being jammed against the ship's side. You must have a gun on slides. With respect to the coals, I think, as a whole, the coals would soon empty themselves out. I can understand coals giving resistance because they yield to the shot. A great many of the gentlemen present have no doubt seen Admiral Sir Thomas Symonds' letter in the "Morning Post," in which he states that there are only 150 powerful merchant ships. He says we shall require all those ships to supply our food, and in fact, in about three weeks we should be starved out if our communication with America was stopped for that time. It is quite evident that merchant ships should be able to defend themselves against foreign ships of their own kind converted into commerce destroyers.[2] Foreign Governments, especially Russia and France, threaten to arm their merchant ships to prey upon ours, and I think it is very hard that our ships may not defend themselves against such ships.[3] Sir Nathaniel Barnaby wrote a long letter in the "Times" the other day, and, as he states, patriotism cuts both ways. What will the Government do for the people, and what will the people do for the Government? The "Oregon" and other ships have carried their water-tight bulkheads right up to the main deck, with the result that, instead of the ship being advertised as "copper-fastened, and carrying an experienced surgeon," it will be said that it has "water-

[1] This picture was presented by the Society of East India Commanders to Captain Charles Shere, late of the H.C. own ship "Buckingham," on the 15th February, 1851, he having been in the action; he was an old Blue, under King Charles's Foundation.

[2] It appears similar to shearing Samson of his hair; our strength is in our commerce. Portugal, Holland, Spain, France, and England have contended for the commerce of the high seas. We have got it; let us keep it.

[3] "Alabamas," for instance; from an article in the "Century" for April, written by a foremast hand, the crew were more like pirates; a Scotchman sagely remarked she had never been in a Southern port, and suggested rushing aft, taking the ship from the Officers, and handing her over to the Northerners for 100,000 dollars.

tight compartments, and won't sink for some seven or eight hours or more." That will be a considerable inducement for passengers to go on board those ships. I think that the wool, as Lieutenant Crutchley has told us, is a considerable protection. With respect to transports, Sir Thomas Symonds says that our Government should do their own transport. I fully concur in that. The Government has never had a better ship than the "Himalaya," and I have no doubt she would give a very good account of herself if required. I think there is no excuse for educating our boys in training ships as they are educated ashore, and keeping them cramped up in harbour. It has a very deleterious effect upon the boys' morals. When a boy is anxious to go to sea, and to visit foreign countries, to keep him cooped up in harbour ships is not only injurious to health, but to morals; he should have three months' drill only. It is not derogatory to carry coals or anything else for your own country. I think it is an honourable profession, and I should say that during peace-time we should do our own transport, and then, if one-third of the crew and the captain were left on board in war-time, the crew could be filled up by merchant seamen thrown out of employ in sailing ships and slow ships, and in that way they would be trained, and would become more or less men-of-war's-men. On the coast of Africa and South America our transports were men-of-war, and were commanded by navigating Officers, and were always in a very creditable state. In the Crimean War a steamship came into Balaclava with boots on board, and yet they sent the ship back to Constantinople for boots. That would not have happened on board a naval transport, because there would have been a court-martial, and somebody would have had to answer for it. It is quite time that the Government did their own transport. I think that, if your commercial marine is worth so much, and increases in value, you must give so much more money to protect it; it is a simple matter of naval insurance.[1]

Lieutenant LOWRY: It seems to me that the right key-note has been struck by the lecturer in saying that merchant steamers must be armed to defend themselves, and not to take the place of men-of-war. I happen to have gone over, not the "Kaikoura," but one of her sister vessels in New Zealand, and I went rather carefully into the subject of her armaments and her suitability for a cruizer. There are a great many defects, as we all know, in ocean steamers with reference to their employment as armed cruizers, and one of the greatest of all has been very well brought out by Captain Long, namely, their bad manœuvring power. He compares a French 4,000 ton corvette with an Atlantic liner, the tonnage of the one being about 12,000 and the other about 4,000; the speed of the corvette 12 knots, and the Atlantic liner 16; diameter of turning circle, French corvette 341 yards, the Atlantic liner from 800 to 1,200 yards; time of turning the circle, 6 minutes for the man-of-war, 10½ minutes for the merchant steamer. Captain Long, in summing up the question of manœuvring powers, says that "so unhandy a vessel dare do nothing but turn her stern to a hostile ship when a mile off." I happened to be coming home from the Australian station at the same time as the "Kaikoura" was on her journey. We had to pass near a large Russian squadron, and, if there was one thing more than another which our Captain prayed for, it was that they would try to come to close quarters with us. The lecturer speaks of two armed merchant cruizers meeting a man-of-war, and he thinks that they would very soon be able to dispose of her by ramming. I do not think they would. I would be very glad, in a small handy ship steaming 12 knots, if the long ocean steamship steaming 16 knots would only try to come to close quarters. Again, we must consider the want of protection of engines and boilers in many of the large Atlantic liners; I am told it would be very difficult to get more than 4 or 5 feet of coal anywhere between the ship's side and the engines and boilers; the engines can be protected, but the boilers cannot. Then, as to the guns' crews, if we take one example of a merchant steamer which has been armed by the Admiralty—the "Hecla"—anyone looking at her will see how utterly exposed the guns' crews are, and if they got to close quarters with

[1] Instead of our Lieutenants being retired,—also Commanders,—they should be given a step in advance, and employed in the Colonial Navies, to rank with, but after, Officers who hold commission of the same date in the Royal Navy: promotion in our Royal Navy need not then stagnate.

one of our ordinary high-bulwark corvettes those guns' crews would stand a very bad chance against rifles and machine-guns. The decks are very much exposed to fire. We also hear it very often stated that the bulkheads of many of these steamers are desperately weak. Whether or no the "Oregon" was lost through that I cannot say, but I know this, that in one of our men-of-war one compartment was filled to within 2 feet of the water-line when the water came spouting through half the rivet-holes, and I do not think that bulkhead would have stood very long without some of the rivets giving way. Then, as to the length of side, taking an Atlantic liner, and supposing that she had six or ten guns, she exposes something like four or five times as much area as a man-of-war of the same tonnage. She presents a target four or five times greater, and the chances of hitting her are therefore very considerably more. The need of careful preparation beforehand was very well emphasized by Lieutenant Crutchley. I went over the stores at Sydney provided for arming merchant vessels, and the guns there consist almost entirely of 64-pounders. The Russian vessels they would have had to meet carried new Krupp guns, a large armament of 4-pounder shell guns, and quick-firing machine-guns,—with which we are utterly unprovided at present on these foreign stations,—and have also actually 600 men. Now it would be a very long time before we could raise 600 men to arm any considerable number of our merchant steamers. With reference to the efficiency of the Officers, I have lately been serving in the Reserve Squadron with some of those who had the pleasure of serving in the Evolutionary Squadron last year, and one and all spoke most highly of the thoroughly efficient way in which the work was carried out by Officers of the Royal Naval Reserve. As a gunnery Officer, I think we should very warmly welcome our brethren of the Royal Naval Reserve on board the "Excellent" for training. I think that is one of the very best suggestions I have heard to-day, and I think I may say for the Officers of the "Vernon" that they would be very glad to see them too. I feel we ought not entirely to neglect the question of torpedo armament for these ships. With these vessels steaming 16 or 18 knots, the opportunities they would have of using the Whitehead would go far to equalize the chance of their coming successfully out of an engagement if they were ever obliged to accept an engagement with a man-of-war. What we heard about Officers of the Royal Naval Reserve giving up almost all the little leave they have to go through a course of gunnery training is, I think, a lesson to all of us, and it ought to induce the Government to meet in a liberal spirit the wishes of men who will put themselves to such a sacrifice as that. I have during the past three months had something to do with the gunnery training of the seamen of the Naval Reserve, and I can only say, after carefully supervising it, attending most of their drills, and examining most of the men myself, that the drill efficiency is decidedly good. I do not consider it smart, but it is good. The trained men of the Naval Reserve are quite up to the average of trained men of the Navy. One great drawback seems to me that they are drilled just at the one kind of gun with which the ship on their station is armed; for instance, on the "Penelope," at Harwich, they are drilled with the old 8-inch muzzle-loading guns only, and so at other stations. They get very little variety of drill, and the result is that men drilled, say on a turret-ship, know nothing of the guns that they would have to fight on board merchant steamers. I wish I could speak in as high terms of their shooting efficiency; they get little or no actual firing in the Reserve ships, most of which lie in close harbours where "short practice" is impossible. Not one in ten can even lay a gun accurately with the ship steady; what they would do at sea in a lively ship at a moving target I can only imagine, so that we must trust, as far as Nos. 1 of our guns go, almost entirely to men of our own Navy. The suggestion about a gunner's mate on board these steamers as gunner seems to me an exceedingly valuable one. It is no doubt very difficult sometimes for the Naval Reserve men to take up the whole of their drill without losing their appointment on board seagoing ships, and so losing their seaman's efficiency. That suggestion is worth careful looking into. I think you could by arranging temporary billets send men there for a year or two years, and then withdraw them. We all know that if men are left in a billet where there is no close supervision put over them for a long time they are liable to get rusty. If some such arrangement was carried out, I have no doubt the men would get a good training, and a training at the guns

they were required to fight at. They would get perhaps a fortnight's drill, which would count for an ordinary week of the training in the Reserve ships. Admiral Salmon spoke of the difficulty of getting men not belonging to the Naval Reserve to enlist; I am very glad to quote an instance in which there was no difficulty. When we were leaving Sydney, without any pressure at all, by merely passing the word round amongst the local seamen, we had five men who presented themselves at once, offering to be enrolled, and many more said they would come if they thought war was certain. When we got to Singapore, the Captain of one of the corvettes told me that they had enrolled twenty extra hands during the war scare. All our Lieutenants on the Active List are pretty well employed now; we want a great many more Officers if it comes to war, and I am heartily glad that we have such Officers as Captain Crutchley and many others of the Royal Naval Reserve to back us up when we come to the scratch.

Lieutenant CRUTCHLEY: Admiral Ommanney asks whether the defensive power of the ships I spoke of are equal to the Admiralty requirements? Yes. Of course there are many things that might be altered for the better. I do not think the shipowners would consent to increase the crews of the vessels unless they received a subsidy for doing so. With regard to the right to use weapons, the subject has been taken up by several speakers. If a man comes to me and demands my purse upon the high seas, I do not see why I am to be hanged as a privateer or pirate if I make the best defence in my power. I do not advocate the armament of these ships for offensive purposes, but, as I put it, seeing that we might be leaving New Zealand, not knowing whether war was declared or not, and looking at the enormous value of one of these solitary ships, and their power of doing damage if they were captured by an enemy, my wish was to point out the necessity of giving them something to defend themselves with against any chance antagonist. As to the matter of the crew being willing to accept the war risk, I can only speak for my own crew, and I am certain every man would have followed me on the occasion I mentioned, had they been asked to do so. Admiral Boys wishes to know whether merchantmen generally prefer carrying foreigners to Englishmen. I do not think, in the better class of ships, that foreigners are admitted if you can possibly get Englishmen. Every preference is given to Englishmen, and I am certain the better class of shipowners prefer shipping Naval Reserve men to any others. I do not think they are as liable to go wrong in a foreign port; they stick to their ship and come home again; they are not so given to desertion as the ordinary run of seamen. I do not know that I can answer Mr. Baden-Powell's arguments, I am not well enough up in law to do that, but I think the same argument applies as to Admiral Salmon's remarks, "that we do not arm the ships to go and look for enemies, but simply to defend themselves." He (Mr. B.-Powell) says a merchantman would be knocked into a cocked hat if it came across anything carrying guns. Perhaps she would, but you are not going to be always hit below the water-line, and a shot from a heavy gun, if it did not hit her engines, would go clean through, and you could plug up the holes. It would appear that an ordinary man-of-war could not catch a fast merchantman; only a similar vessel to herself could bring her into action, and then the argument would hold either way. Admiral Fremantle quotes the "Oregon," and asks what will happen if the fore compartments were filled with water. I did not take the "Kaikoura" as the best ship that can be pitched upon, because we know that, were her biggest forward compartment filled, she would draw, as nearly as I can get it, assuming she were loaded for a draught of 24 feet, the fact of the biggest foremost compartment being filled would put her down to 29 feet. Of course that would not render the ship absolutely unseaworthy, and, though she would not be the sort of ship you would like to go to sea with in a gale of wind, there would be a fair chance of getting to port. I simply wish to point out that we must make the best of the materials we have got on hand. Of course, if we could build these ships with twin screws, and subdivide them into more compartments, it would be a great deal better, but, with the ships we have, my object is to give them all the security possible. Of course you could arm them better. You could put machine-guns into them, but let us have something to strike a blow with in our own defence.

Admiral FREMANTLE: My question was whether, taken from a mercantile point of view, you thought there were any special objections to their using them.

Lieutenant CRUTCHLEY: None whatever. I am putting my wishes as modestly as possible. With regard to the manœuvring power of these ships as opposed to a corvette, undoubtedly the corvette, if she could get a chance to get the inside circle, would give her stem and ram her; but I was very careful to say, two of these ships opposed to a corvette, and I think, even with their bad manœuvring power, two merchant ships would be able to give the ram blow, as, if one did not get her, the other would. I have now only to thank you very much for the kind manner in which you have received my paper.

The CHAIRMAN: I have now to ask you to give your thanks to Lieutenant Crutchley for his interesting lecture. I had hoped myself to have said a few words upon this question, having been so much mixed up with the Reserves for a few years. However, the time is getting so late that I have made up my mind to say nothing on the point beyond this general remark that it is very satisfactory to hear so many people who know the matter speak so well of Naval Reserve Officers and Naval Reserve men. My opinion is that in time of war they would be the mainstay of our nation.